Structural Change in U.S. Food Manufacturing, 1958 to 1997

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The focus of this paper is simple: to examine trends in aggregate and market concentration and to consider the factors driving these trends. Despite the simple task, the answer is exceedingly difficult and expensive. Necessary data either do not exist or are too expensive for an academic researcher to obtain. The data differ depending on whether one assesses oligopsony or oligopoly. Input markets in food processing are often dramatically more narrowly defined in both product and geographic space than output markets. Farmers are concerned about the number of buyers they face whereas consumers' worry about the number of sellers competing for their business. The economics behind the concentration trends is also complex and controversial.

John Sutton wrote nearly 600 pages in his 1991 book that addressed the question of how market concentration relates to market size. The book remains an outstanding example of applied industrial organization as he included both a theoretical understanding of the question and an exhaustive empirical check of the theory. I examine his main points in this paper, but fail to support his main point that there is a fundamental difference between market size/setup costs and concentration in industries selling homogeneous goods and those selling consumer goods with the support of advertising. I first learned as a young research assistant to Fritz Mueller in1974 that it was never wise to pool producer and consumer good industries, as the pooling would hide substantial differences between those two groups. Hence, I embraced Sutton's book as further evidence of this fundamental truth. Nevertheless, my analysis of U.S. food manufacturing concentration data does not support the fundamental difference Sutton attributed to exogenous as opposed to endogenous sunk costs in these different industry groups.

This paper promises more than it delivers. In September when this paper was planned, we arranged for a Special Tabulation of the 1992 and 1997 Census of Manufactures to provide needed data to examine concentration in food manufacturing over the last four decades. Interestingly, the Census no longer publishes a concentration report from its Economic Census and has abandoned providing any concentration data at the product class level (e.g., SIC 20321, canned baby foods rather than the industry SIC 2032, canned specialities, which includes SIC 20322, canned soup). The product class data are preferred since they use a wherever-made method and use the more narrow market definition thus provide more accurate concentration data. The Census had provided concentration reports for manufacturing at both the industry and product class level since1958. Previously, the Congress would have the Census prepare such reports. In 1948, Senator Taft chaired the Joint Committee on the Economic Report and issued a report entitled "Current Gaps in Our Statistical Knowledge" which asked for more current information on business concentration. In 1957, the Subcommittee on Antitrust and Monopoly issued their report on "Concentration in American Industry," which provided concentration data for 1954, and 1935 and 1947 as well. In the letter of transmittal of that report, Joseph O'Mahoney, then chair of the Joint Economic Committee wrote:

> "Congress, the administrative agencies, and the general public should be supplied with a continuing body of information which would show the level or extent of

> economic concentration in the various industries, as well as the changes which have occurred and are constantly taking place. Data of this type are essential to formulate and implement policies and programs in this area." ... "It is felt that publication of a large body of authoritative data in a field in which such data have been notably lacking for so long will serve a useful and timely public purpose in achieving a better insight in to the structure of our industrial economy."

Congress needs to reread those appeals for more timely and thorough data as the Census has dramatically reduced the amount and timeliness of its concentration data. The last full concentration report was for the 1987 Census and did not include a product class report, where the data are reported on a wherever-made basis, which yields the most accurate concentration data. In 1992 the Census did not issue a written concentration report but posted industry concentration data for manufacturing on its Web site. With backing from the Economic Research Service of the U.S. Department of Agriculture, the Food Marketing Policy Center at the University of Connecticut and the Food Systems Research Group at the University of Wisconsin, we asked Census for a special tabulation to provide such data. Unfortunately, budget problems, time pressures and resource constraints intervened and we managed to secure only the product class concentration data for 1992 and at a cost of $5,000 (the data are in appendix A1). We continue to seek additional data, but it is disappointing that in May 2000 we have no concentration data at even the four-digit industry level from the 1997 Census of Manufacturing and that we had to pay to see the product class concentration data for 1992. Thus for today's paper, we examine the data we have and await the delivery of the remainder of the requested data.

Overall Industrialization and Consolidation

The American food system continues to consolidate and industrialize as consumers splinter into more segments and technology allows catering to the diversity of demands while retaining large economies of scale. Economic markets can be incredibly efficient in making sense out of the economic chaos involved in moving products from production to consumption as they summarize the information contained in buyers' demands and sellers' supplies. In the real world, however, traditional agricultural markets are not as perfect as the economist's model suggests as they miss opportunities to link producers and processors in more profitable arrangements. For example, major chicken processors have been fully integrated by ownership from the hatchery to the processing plant for decades. They merely hire contract growers to raise the birds to market weight without ever transferring ownership and they even supply the feed and other inputs required for the growout operation. Other industries have turned to legal contracts to secure input supplies tailored to their operations (e.g., vegetables for processing) rather than using markets or ownership of the farms (Drabenstott). Farmers benefit in lowering their risks and processors are assured of supplies with appropriate features. Several major processors have entered strategic alliances with growers where they contract for character-specific raw products in a relationship that all parties expect to be ongoing (van Duren et. al.). Little to no data exist on these private transactions and hence economic assessments are difficult and require industry cooperation, either willing cooperation or forced cooperation by the legal system.

Economists understand the benefits of these non-market transactions, but also the costs as more product volume moves through non-market methods the less is known about true product values as key economic information summarized by price becomes more difficult to discover. To date

most of these non-market arrangements involve linking the processing and production stages of the marketing system. However, other stages have established non-market coordination in what has been termed 'supply chain management'. Large retailers now contract for much of the produce they sell rather than buy their produce at the various regional markets. Much of the industrialization has featured improved information, tailored inputs, and reduced cost of production and processing. Consumer concerns arise from whether there will be sufficient competition to force such efficiencies to be passed on as lower prices and rural communities wrestle with major issues resulting from factory farms that reduce the number of family farms and add to environmental concerns. Even producers who entered these contracts worry whether they will receive fair prices for their products once the marketplace is removed or diminished.

All stages of the vertical system are becoming more concentrated as larger operations increase their size. At the same time, there is an enhanced bimodal distribution as the larger firms get larger and the number of smaller firms increases. It is the middle sized firm that is most endangered by the consolidation movement. Whether in farming or retailing, as the largest firms increase their share of the sector's output a growing number of smaller firms emerge in the cracks and eddies left behind by the larger firms. Once those small markets prove successful, the large food firms acquire the once small, risk-taking firm. A current example is Nestle's purchase of Powerbar, an innovative company that has proved there is a market for energy bars.

The processing stage has the fewest number of establishments in the vertical food system, but the processor/food manufacturer is often consider the most powerful, influential firm in the system–the marketing channel leader. These are the food firms the world knows by name: Philip Morris, Coca-Cola, Cargill, Kelloggs, and so on (**Table 1**). About 80% of all raw domestic food products pass through this stage, with only produce and eggs avoiding processing since they only require minimal market preparation services like cleaning, sorting, and packaging (Connor et. al). Processors and manufacturers, hereafter referred to as processors, add the form utility to the raw agricultural products and have invested heavily in market research to understand consumer demands. They buy or contract from farmers who have been advised (including through price signals) or legally bound to supply raw foodstuffs with desired characteristics for transforming into the products consumers eventually buy.

Table 1. The Top 25 Food Processing Companies, 1998

Rank	Company	Food Sales	Total Sales	Percent Food
		Millions $		
1	Philip Morris Companies, Inc.	31,527	71,592	44
2	Conagra, Inc.	28,840	28,840	100
3	Cargill, Inc.	21,400	51,000	42
4	Pepsico, Inc.	20,917	20,917	100
5	The Coca-Cola Company	18,800	18,868	100
6	Archer Daniels Midland Company	16,109	16,109	100
7	Mars Inc.	14,000	14,000	100
8	IBP, Inc.	13,259	13,259	100
9	Anheuser-Busch Companies, Inc.	12,832	12,832	100
10	Sara Lee Corporation	10,800	20,000	54
11	H.J. Heinz Company	9,209	9,209	100
12	Nabisco, Inc.	8,734	8,734	100
13	Bestfoods	8,400	8,400	100
14	Nestle USA, Inc.	7,800	7,800	100
15	Dairy Farmers of America	7,000	7,000	100
16	Kellogg Company	6,830	6,830	100
17	Campbell Soup Company	6,696	6,696	100
18	The Pillsbury Company	6,500	6,500	100
19	Tyson Foods, Inc.	6,356	6,356	100
20	General Mills, Inc.	6,033	6,033	100
21	Quaker Oats Company	5,010	5,010	100
22	The Proctor & Gamble Company	4,376	37,154	12
23	Dole Food Co., Inc.	4,336	4,336	100
24	Hershey Foods Corporation	4,300	4,300	100
25	Land O' Lakes, Inc.	4,195	4,195	100

Source: Food Processing, The 1998 Top 100 Food Companies, December 1998.

Food processors location decisions involve a calculated tradeoff between processing costs, including input costs, and the costs of delivering their finished products to consumers. Since most of the country's consumers live near the coasts and most of the raw agricultural foodstuffs come from the middle of the country, the location decision is not always obvious. Over time with modern transportation and refrigeration technologies, the balance has shifted to locating where the inputs are produced rather than where the people live. California is in the unique situation of being both the number one farm state and the number one food processing state by far (**Table 2**). It has both the agricultural commodities and the population. States like Nebraska and Kansas, 4th and 5th in farm value, rank 24th and 27th respectively in processing. Overall there is a strong association between farm value rank and food processing rank, with a simple correlation coefficient of .75. In certain crops it is even more pronounced, like in wine or broilers. Broiler processors prefer to locate within a 25 mile radius of where their chickens are raised to market weight and the leading states in both production and processing closely follow a geographical pattern known as the "broiler belt", but direct competitors avoid locating too close to a rival and hence do not compete for growout services (Rogers, 1998).

Table 2. Ranking of States by Value of Agricultural Products Sold, 1997 and Value-Added in Food Manufacturing, 1996

State	Rank in		1997 Value of Agricultural Products Sold			1996 Value Added in Manufacturing			
	Agriculture	Food Manu-facturing	$ Million	Percent of U.S. Total	Cumulative Percent	Food Manufacturing $ Million	Percent of U.S. Total	Total Manufacturing $ Million	Food Manu-facturing as Percent of State's Total
California	1	1	23,032	11.7	11.7	20,265	11.3	188,805	10.7
Texas	2	3	13,767	7.0	18.7	11,778	6.6	116,631	10.1
Iowa	3	10	11,948	6.1	24.8	6,367	3.6	27,021	23.6
Nebraska	4	24	9,832	5.0	29.8	2,549	1.4	9,218	27.6
Kansas	5	27	9,207	4.7	34.4	2,136	1.2	18,820	11.4
Illinois	6	2	8,556	4.3	38.8	12,602	7.1	92,011	13.7
Minnesota	7	15	8,290	4.2	43.0	5,023	2.8	34,716	14.5
North Carolina	8	12	7,677	3.9	46.9	5,144	2.9	76,475	6.7
Florida	9	14	6,005	3.1	49.9	5,071	2.8	38,621	13.1
Wisconsin	10	8	5,580	2.8	52.8	6,379	3.6	53,619	11.9
Arkansas	11	20	5,480	2.8	55.6	3,542	2.0	18,512	19.1
Missouri	12	9	5,368	2.7	58.3	6,377	3.6	40,208	15.9
Indiana	13	17	5,230	2.7	60.9	4,304	2.4	61,896	7.0
Georgia	14	6	4,993	2.5	63.5	6,796	3.8	51,753	13.1
Washington	15	19	4,768	2.4	65.9	3,582	2.0	31,929	11.2
Ohio	16	4	4,684	2.4	68.3	9,786	5.5	105,497	9.3
Colorado	17	21	4,534	2.3	70.6	2,919	1.6	19,215	15.2
Oklahoma	18	32	4,146	2.1	72.7	1,396	0.8	15,875	8.8
Pennsylvania	19	5	3,998	2.0	74.7	9,386	5.3	82,922	11.3
South Dakota	20	39	3,570	1.8	76.5	674	0.4	3,974	17.0
Michigan	21	11	3,568	1.8	78.3	5,149	2.9	85,688	6.0
Idaho	22	31	3,346	1.7	80.0	1,467	0.8	7,977	18.4
Mississippi	23	29	3,127	1.6	81.6	1,823	1.0	17,295	10.5
Alabama	24	30	3,099	1.6	83.2	1,551	0.9	27,451	5.7
Kentucky	25	23	3,064	1.6	84.8	2,685	1.5	35,040	7.7
Oregon	26	28	2,969	1.5	86.3	2,064	1.2	21,838	9.5

State	Rank in		1997 Value of Agricultural Products Sold			1996 Value Added in Manufacturing			
	Agriculture	Food Manu-facturing	$ Million	Percent of U.S. Total	Cumulative Percent	Food Manufacturing $ Million	Percent of U.S. Total	Total Manufacturing $ Million	Food Manu-facturing as Percent of State's Total
North Dakota	27	41	2,869	1.5	87.7	537	0.3	1,808	29.7
New York	28	7	2,835	1.4	89.2	6,419	3.6	90,665	7.1
Virginia	29	13	2,344	1.2	90.4	5,090	2.8	42,519	12.0
Tennessee	30	16	2,178	1.1	91.5	4,632	2.6	42,288	11.0
Louisiana	31	25	2,031	1.0	92.5	2,435	1.4	25,125	9.7
Arizona	32	33	1,903	1.0	93.5	1,365	0.8	22,850	6.0
Montana	33	49	1,871	1.0	94.4	165	0.1	1,707	9.7
New Mexico	34	45	1,618	0.8	95.2	333	0.2	11,745	2.8
South Carolina	35	34	1,588	0.8	96.0	1,312	0.7	30,769	4.3
Maryland	36	22	1,312	0.7	96.7	2,729	1.5	17,455	15.6
Wyoming	37	50	899	0.5	97.2	148	0.1	999	14.8
Utah	38	35	877	0.4	97.6	1,032	0.6	11,239	9.2
New Jersey	39	18	697	0.4	98.0	4,136	2.3	49,995	8.3
Delaware	40	37	691	0.4	98.3	920	0.5	5,791	15.9
Hawaii	41	42	497	0.3	98.6	533	0.3	1,609	33.2
Vermont	42	46	476	0.2	98.8	320	0.2	3,986	8.0
Massachusetts	43	26	454	0.2	99.0	2,272	1.3	44,047	5.2
West Virginia	44	47	447	0.2	99.3	257	0.1	8,965	2.9
Maine	45	40	439	0.2	99.5	541	0.3	6,675	8.1
Connecticut	46	36	422	0.2	99.7	947	0.5	24,772	3.8
Nevada	47	44	357	0.2	99.9	397	0.2	3,275	12.1
New Hampshire	48	43	149	0.1	100.0	478	0.3	10,815	4.4
Rhode Island	49	48	48	0.0	100.0	249	0.1	5,407	4.6
Alaska	50	38	25	0.0	100.0	683	0.4	1,470	46.5
Total			196,865	100.0		178,742	100.0	1,748,981	10.2

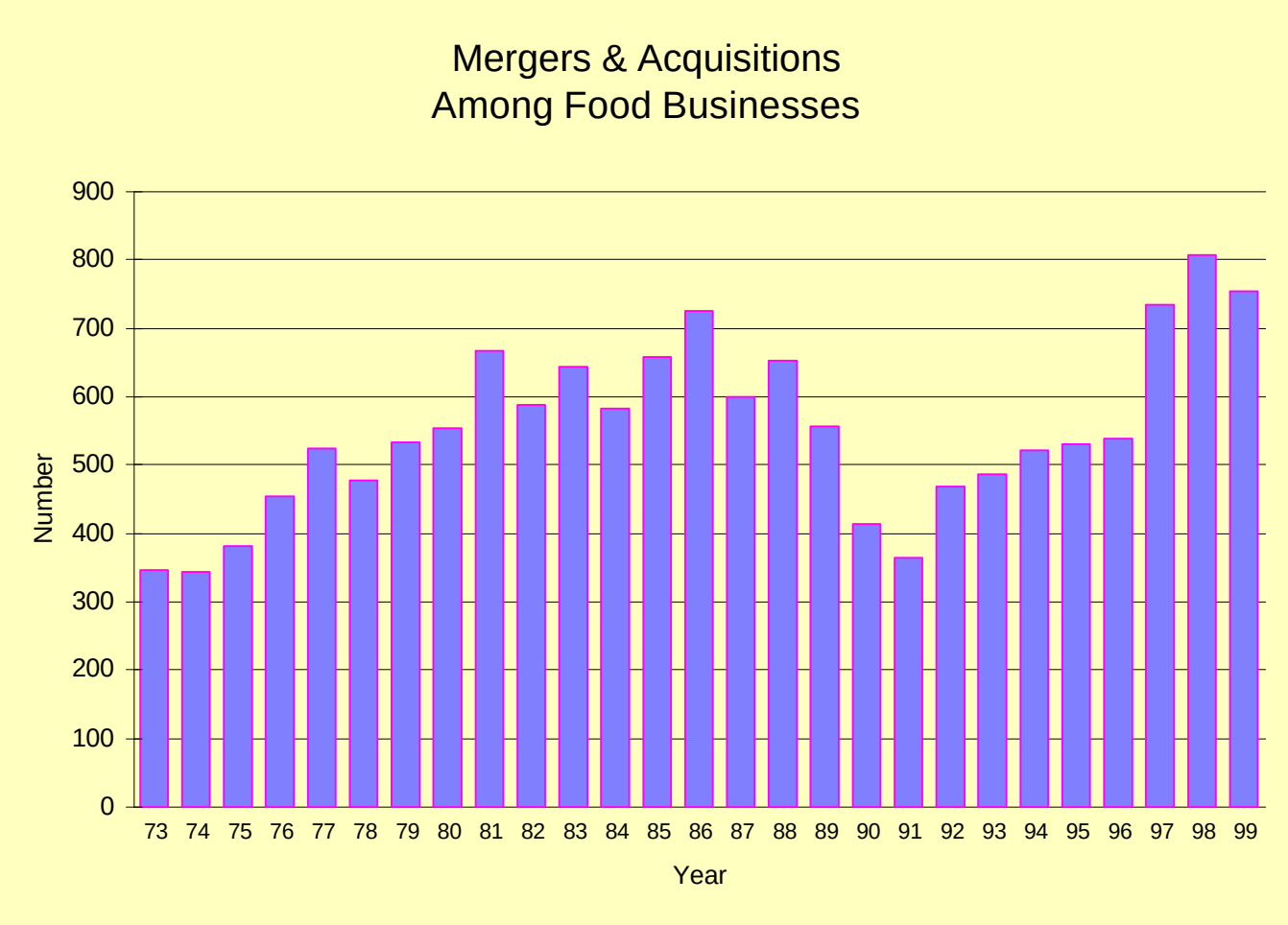
Source: 1997 Census of Agriculture - State Data, Table 1, and 1996 Annual Survey of Manufacturers, Geographic Area, Table 2.

Food and tobacco processing has seen the most dramatic consolidation in this century as merger patterns have followed the four great merger movements of the general economy. The first major merger wave occurred around the turn of the century and created some of the famous trusts that antitrust legislation was suppose to prevent (Connor and Geithman). For example, American Tobacco and General Mills were formed during this merger wave. The next wave came during the roaring 1920's when companies such as General Foods were being formed through merger. The third merger wave was in the 1960's and was characterized by amazing conglomerates being formed as unrelated firms sought management synergies such as ITT buying Continental Baking. The fourth merger movement came in the late 1970's and 1980's and was a wild period of leveraged buyouts and hostile takeovers funded with questionable, often illegal, financial instruments. Food companies were at the forefront of these mergers with record setting deals such as the $25 million leveraged buyout of RJR Nabisco. The largest food and tobacco processor, Philip Morris Cos. is essentially a case history in a merger built business. Starting from its dominant position in cigarettes, Philip Morris purchased such already huge companies as Miller Brewing, General Foods (who already had bought Oscar Mayer), and Kraft Foods. Few American shoppers now know the parent company of the branded goods they bring home from the supermarket.

It appears that we are in the midst of a fifth merger wave and again the food businesses are major players (**Figure 1**). Most of the food related mergers involve food processing firms, including some the largest mergers in history, but increasingly mergers in retailing, food service and wholesaling are commonplace. Wholesalers are increasing their ownership of retailers as they seek to survive in the modern food system. Some of the failures of the previous merger wave are being undone as firms now seek brands from other firms as they selectively add and subtract from their portfolio of brands. Others merely purchase firms whose brands fit well with their current offerings. This current merger wave is more horizontal in nature as processing firms seek merger partners among current rivals. Gone are the wild conglomerate mergers as firms now seek to consolidate their hold on leading positions in markets where they currently hold a strong position. Some economists have become concerned about the growing concentration and march toward oligopoly in almost every market. There is little evidence of any positive benefits from such mergers outside of the stock market evaluation of these firms. The stock market rewards down-sizing as a cost efficiency and increased market share enhances profitability potential through uncontested price increases. The typical firm defenses of increased efficiencies and productivity gains prove elusive to document in consumer savings or enhanced farm revenues.

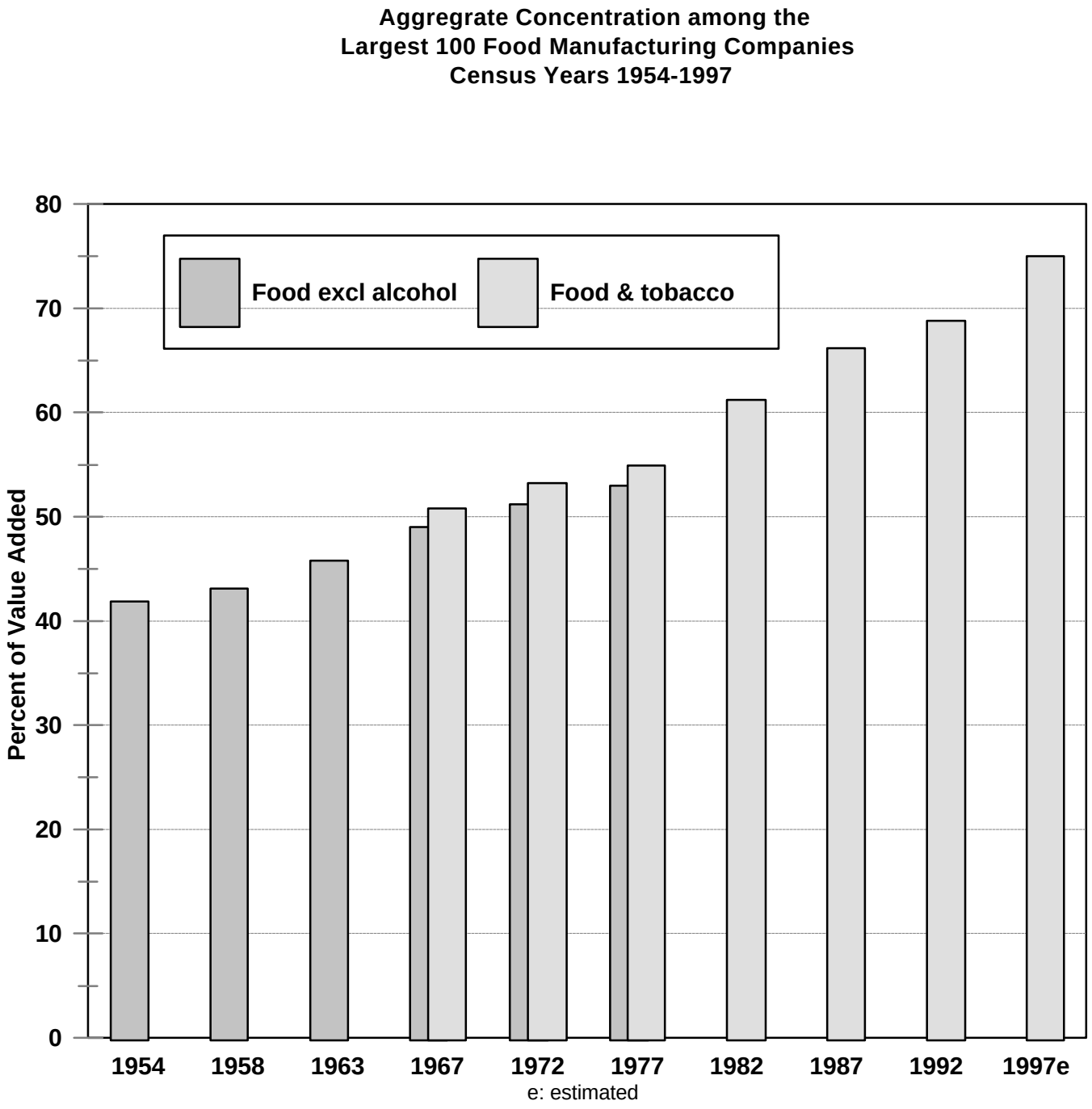
The largest food processors among the roughly 16,000 companies involved in food processing are huge, both in absolute terms and relative to the others. The largest 100 food and tobacco processors accounted for nearly 80% of the value-added in 1995 (**Figure 2**), almost doubling their share since 1954. The top 100 is itself skewed toward the very large, with the top 20 firms accounting for over 50% of total value-added in 1995, more than doubling its 1967 share (**Figure 3**). The remaining 80 firms among the top 100 firms actually lost share over the last 30 years. The sector is best described by a big-small model, where extremely large firms control leading positions in most markets and smaller companies, including startups, operate in a competitive fringe trying to serve a particular market niche or develop a new idea. The large companies know that if a new idea turns promising they can buy the entire company after the startup has borne much of the risk.

Figure 1.



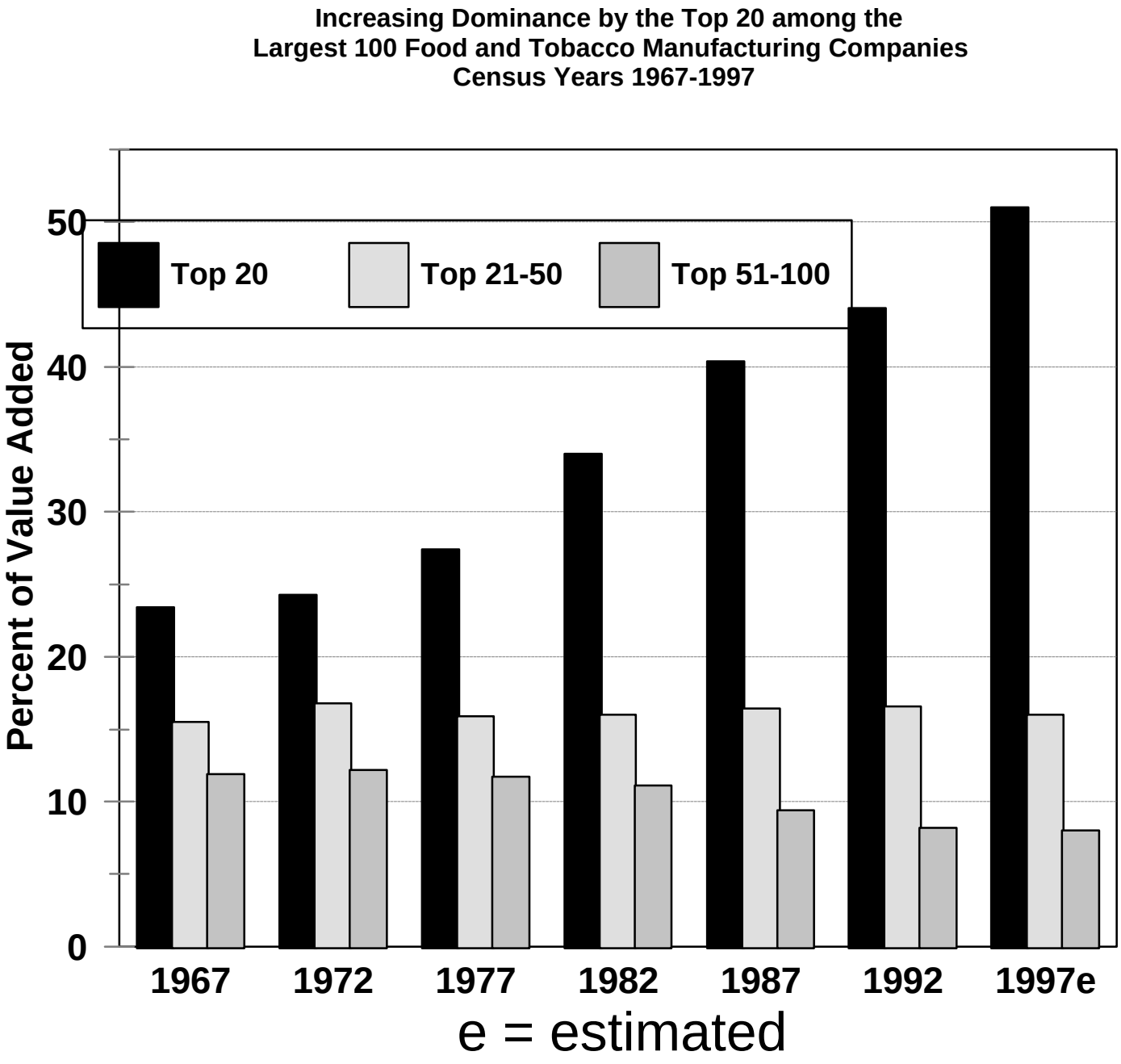
Source: The Food Institute.

Figure 2.



Source: Special Tabulations of the Census of Manufactures, 1954 to1992 and 1997 was estimated from trade sources.

Figure 3.



Source: Special Tabulations of the Census of Manufactures, 1954 to1992 and 1997 was estimated from trade sources.

The dramatic size of the top 20 companies is seen from the recently received 1992 special tabulation, that we just received (**Table 3**). These firms are multiplant operations, averaging 56 plants per firm. The number of establishments per firm declines with each size class, until the firms ranked lower than the top 500 having an average of 1.1 establishment per firm. The top 20's payroll in 1992 was about the same as the entire payroll for the 15,652 firms ranked lower than the top 500. The leading 20 food and tobacco companies are also the most heavily involved in the highest value-added products, with a ratio of value-added to shipments of .54 in 1992, much higher than the .41 that the next 30 largest firms had or the .35 ratio of that the firms ranked 51to 100 had.

The previous figures refer to overall size, or what economists call aggregate concentration, but market performance hinges on market concentration–the extent of market power held by leading firms in a well-defined economic market. Market power is what enables a firm to enhance prices to buyers, to extract price reductions from its product suppliers, and to subdue rivals. Although market definition is a complex task, it can be roughly approximated by the Census four-digit industry group, the 4-digit SIC. The food and tobacco processing sector had 53 such industries in 1992, most of which remain too broadly defined, certainly so on the input side as substitution opportunities are much greater in consumption than production. Although there are no monopolies and several industries are what economists call workably competitive (where the 4 largest firms have a combined market share of 40% or less) most have become oligopolies (**Table 4**). In oligopolies firms get some of the advantages of market power without government regulation that would come if they were monopolies (Zachary). Over time most of these 4-digit industries have lost companies, averaging a 25.5% reduction in company counts, and have increased in concentration as measured by the four-firm concentration ratio, CR4, which increased on average from 43.9 in 1967 to 53.3 in 1992, the last year data are available.

Table 3. Industry Statistics by Company Ranking Group for the Food and Tobacco Industries: 1992

Company ranking group	Number of companies	Number of estabs	estab per company	Total employment (number)	percent of total employment	percent of total payroll	percent of total value of ship.	Value added (Thou. $)	Percent of value added	Ratio of VA to VS
All Companies	16,152	20,912	1.3	1,540,787	100.00%	100.00%	100.00%	184,466,526	100.0%	0.417
1 - 20	20	1,121	56.1	340,639	22.11%	27.30%	34.31%	81,254,954	44.05%	0.536
21 - 50	30	755	25.2	216,107	14.03%	14.42%	16.84%	30,582,727	16.58%	0.411
51 - 100	50	686	13.7	151,735	9.85%	9.43%	9.75%	15,127,702	8.20%	0.351
101 - 200	100	734	7.3	138,611	9.00%	8.62%	8.46%	13,087,079	7.09%	0.350
201 - 500	300	1,052	3.5	195,384	12.68%	12.32%	9.86%	15,333,917	8.31%	0.352
501 and higher	15,652	16,564	1.1	498,311	32.34%	27.90%	20.80%	29,080,147	15.76%	0.316

SOURCE: Special tabulation from the Census of Manufactures, U.S. Census Bureau. Draft 04/28/2000
Prepared under the supervision of Patrick Duck of the Census Bureau and Richard Rogers of the U. of Massachusetts.
Purchased by the Food Marketing Policy Center, University of Connecticut.

Table 4. Concentration in Food and Tobacco Processing Industries, 1967 to 1992

SIC	Name	Concentration-CR4 1967	1987	1992	Change 67-87	Change 87-92	Number of Companies 1967	1987	1992	% Change 67-87	% Change 87-92	VA/VS	Ag Input Share	Co-op VS Share
20+21	All food & tobacco products (a)	51	66	75	15	9	26958	15790	16151	-41.4	2.3	38.8	-	5.4
2011	Meat packing plant products	26	32	50	6	18	2529	1328	1296	-47.5	-2.4	11.6	75.9	0.1
2013	Sausages & prepared meats	15	26	25	11	-1	1294	1207	1128	-6.7	-6.5	26.9	0.0	0.1
2015	Poultry and egg processing	15	28	34	13	6	709	284	373	-59.9	31.3	27.6	68.5	5.0
2021	Butter	15	40	49	25	9	510	44	31	-91.4	-29.5	9.4	19.1	62.8
2022	Cheese, natural and processed	44	43	42	-1	-1	891	508	418	-43.0	-17.7	20.2	47.2	23.4
2023	Condensed and evaporated milk	41	45	43	4	-2	179	124	153	-30.7	23.4	40.8	36.1	27.1
2024	Ice cream and ices	33	25	24	-8	-1	713	469	411	-34.2	-12.4	32.4	7.2	6.0
2026	Fluid milk	22	21	22	-1	1	2988	652	525	-78.2	-19.5	26.4	56.4	17.2
2032	Canned specialities	69	59	69	-10	10	150	183	200	22.0	9.3	49.6	5.7	0.5
2033	Canned fruits and vegetables	22	29	27	7	-2	930	462	502	-50.3	8.7	45.8	28.0	13.7
2034	Dehyd. fruits, vegetables, soups	32	39	39	7	0	134	107	124	-20.1	15.9	51.2	15.0	14.2
2035	Pickles, sauces, salad dressings	33	43	41	10	-2	479	344	332	-28.2	-3.5	50.4	10.3	1.8
2037	Frozen fruits and vegetables (b)		31	28	2	-3		194	182	42.6	-6.2	45.2	46.2	8.4
2038	Frozen specialties (b)		43	40	5	-3		244	308	-37.1	26.2	49.9	5.9	0.2
2041	Flour & other grain mill products	30	44	56	14	12	438	237	230	-45.9	-3.0	26.8	70.1	1.0
2043	Cereal breakfast foods	88	87	85	-1	-2	30	33	42	10.0	27.3	74.7	8.7	0.0
2044	Milled rice and byproducts	45	56	50	11	-6	54	48	44	-11.1	-8.3	38.0	88.2	44.5
2045	Prep. flour mixes & refr. doughs	63	43	39	-20	-4	126	120	156	-4.8	30.0	48.7	0.0	0.0
2046	Wet corn milling	68	74	73	6	-1	32	31	28	-3.1	-9.7	43.3	53.3	0.0
2047	Dog, cat, and other pet food	46	61	58	15	-3		130	102	-11.6	-21.5	54.1	7.0	0.2
2048	Prepared feeds, n.e.c. , (b) (e)	22	20	23	-2	3		1182	1161	-25.1	-1.8	22.7	16.0	4.2
2051	Bread, cake, & related products	26	34	34	8	0	3445	1948	2180	-43.5	11.9	64.9	0.0	0.2
2052	Cookies and crackers	59	58	56	-1	-2	286	316	374	10.5	18.4	65.0	0.0	0.0
2053	Frozen bakery products		59	45		-14		103	160		55.3	51.5	0.0	0.0
2061	Sugar cane mill products	43	48	52	5	4	61	31	37	-49.2	19.4	40.7	81.3	10.7
2062	Refined cane sugar	59	87	85	28	-2	22	14	12	-36.4	-14.3	18.1	0.0	15.5
2063	Refined beet sugar	66	72	71	6	-1	15	14	13	-6.7	-7.1	33.5	75.3	29.3
2064	Candy & confectionary (c)		45	45		0			705			55.0	1.9	0.7
2066	Chocolate and cocoa products		69	75		6		173	146		-15.6	46.6	0.3 d	0.0
2067	Chewing gum (c)	86	96	96	10	0	19	8	8	-57.9	0.0	68.8	0.0	0.0
2068	Nuts & seeds		43	42		-1		79	102		29.1	39.8	35.5	25.9
2074	Cottonseed oil mill products	42	43	62	1	19	91	31	22	-65.9	-29.0	22.7	67.6	16.0
2075	Soybean oil mill products	55	71	71	16	0	60	47	42	-21.7	-10.6	11.1	76.0	16.8
2076	Vegetable oil mill products, n.e.c.	56	74	89	18	15	34	20	18	-41.2	-10.0	19.2	70.8	4.3

SIC	Name	Concentration-CR4 1967	1987	1992	Change 67-87	Change 87-92	Number of Companies 1967	1987	1992	% Change 67-87	% Change 87-92	VA/VS	Ag Input Share	Co-op VS Share
2077	Animal and marine fats and oils	28	35	37	7	2	477	194	159	-59.3	-18.0	42.7	0.0	1.5
2079	Shortening and cooking oils	43	45	35	2	-10	63	67	72	6.3	7.5	30.4	0.0	4.3
2082	Malt beverages	40	87	90	47	3	125	101	160	-19.2	58.4	53.5	1.9	0.0
2083	Malt and malt byproducts	39	64	65	25	1	32	15	16	-53.1	6.7	28.9	85.4	0.0
2084	Wines, brandy, and brandy spirits	48	37	54	-11	17	175	469	514	168.0	9.6	43.0	27.0	2.5
2085	Distilled liquor, except brandy	54	53	62	-1	9	70	48	43	-31.4	-10.4	59.5	2.0	0.1
2086	Bottled and canned soft drinks	13	30	37	17	7	3057	846	637	-72.3	-24.7	38.5	0.0	4.1
2087	Flavoring extracts & syrups n.e.c.	67	65	69	-2	4	401	245	264	-38.9	7.8	70.6	0.0	0.3
2091	Canned & cured seafood inc soup	44	26	29	-18	3	268	153	144	-42.9	-5.9	36.9	0.0 d	0.0
2092	Fresh or frozen packaged fish	26	18	19	-8	1		579	600		3.6	26.8	0.0 d	0.0
2095	Roasted coffee	53	66	66	13	0	206	110	134	-46.6	21.8	40.5	0.0 d	0.6
2096	Potato chips and similar products	41	62	70	21	8		277	333		20.2	65.5	19.4	0.0
2097	Manufactured ice	33	19	24	-14	5	688	503	513	-26.9	2.0	70.0	0.0	0.0
2098	Macaroni and spaghetti	34	73	78	39	5	190	196	182	3.2	-7.1	58.6	0.0	0.0
2099	Food preparations, n.e.c.	23	26	22	3	-4	1824	1510	1644	-17.2	8.9	52.4	8.3	0.6
2111	Cigarettes	81	92	93	11	1	8	9	8	12.5	-11.1	74.7	2.3	0.0
2121	Cigars	59	73	74	14	1	126	16	25	-87.3	56.3	55.5	4.7	0.0
2131	Chewing, smoking tobacco, snuff	51	85	87	34	2	41	23	23	-43.9	0.0	71.1	4.2	0.0
2141	Tobacco stemming and redrying	63	66	72	3	6	54	62	32	14.8	-48.4	19.0	49.5	0.0
	means for SIC 20-21	43.9	51.1	53.3	7.5	2.1				-25.5	3.0	42.8	24.1	6.9

Note: CR4s are from 4-digit industry data, where available, else 4 digit product class data from Rogers.

(a): For SIC 20+21 the concentration data are the percent of the sector's value-added held by the top 100 food and tobacco companies.

(b): The changes are from 1972, not 1967.

(c): In 1992, SIC 2067, Chewing Gum, was combined with SIC 2064. The 1992 data for SIC 2067 are estimated by Rogers.

(e): 1967 CR4 is estimated.

(d): Cocoa, coffee, and fish inputs were ignored.

Where: VA/VS is the ratio of value-added to the value-of-shipments, percent, 1987 data.

Ag Input share is the percentage of total cost of materials accounted for by agricultural inputs, 1987 data.

Co-op VS Share is the 1987 estimated percent of value-of-shipments accounted for by the 100 largest agricultural marketing cooperatives.

Source: Census of Manufacturing, prepared by Richard T. Rogers, Department of Resource Economics, UMass, Amherst, MA 01003.

Oligopsony Issues in Food Processing

Forty years ago Lanzillotti presented a paper "The Superior Market Power of Food Processing and Agricultural Supply Firms--Its Relation to the Farm Problem" at our annual professional meeting in a session titled "Market Power and the Farm Problem". Three discussants--including one from a chain store association and another from a major meat packing company--gave opposing reactions. It is both humbling and disturbing to present this paper today in that our profession has not made much progress, despite many serious efforts, in resolving the debate. Opposing views still exist, including from the chain store associations and the meatpacking industry.

Lanzillotti's paper relied on structural data and the S-C-P paradigm to demonstrate that farmers are disadvantaged in that they buy from and sell to firms with substantial, and growing, market power. His discussants challenged his reliance on the S-P connection and one discussant, Mr. Clifton from John Morrell & Co., even concluded his remarks with an acceptance that some meat packers, including his own, had market power but called on researchers to focus on firm strategies, rather than structure, and pursue the promising area of game theory, despite the difficulties involved in obtaining the necessary data. He used a game-theoretic example of his firm and its main rival Hormel in the St. Paul market. His suggested approach has been adopted by several researchers studying monopsony issues in a dramatically more concentrated meat industry than was the case in 1960. In 1992 after being bought and sold a few times, the John Morrell meatpacker, then owned by Chiquita, closed its last plant.

Lanzillotti assembled data for 51 industries (28 were food and tobacco processing industries) which were relevant to farmers, both on the input and output sides. His data led him to conclude "The foregoing statistics on the structural characteristics and growth path of the food processing and agricultural supply industries are fairly strong circumstantial evidence of high and growing market power in the economic sense." (page 1239-40) Since companies had higher shares than plants, he concluded that it was not technical efficiencies that were driving firms to ever larger shares. He gave the trends in mergers and acquisitions to further sound the alarm that "Farmers, as sellers, have found themselves at the mercy of oligopsonies, collusion, and monopsony." (page 1240).

Lanzillotti could not have been pleased by the major consolidations that have taken place since 1954, but they demonstrate that his main conclusion applies even more so today: "...the structural features of agriculture, i.e., the size-distribution of farms, product homogeneity, level of managerial skill, exit barriers, demand-supply elasticities, etc., are conducive to an inferior bargaining position for farmers vis-a-vis both buyers and suppliers." (page 1243) He saw two approaches to offset this imbalance "a) to build countervailing power through direct or indirect government action or special additional antitrust immunities for agriculture, and (b) to dissolve or lessen the market power of groups to whom the farmer sells or from whom he buys." (page 1246) He clearly favored the second approach as he disliked "...the further cartelization of agriculture." (page 1246) and he thought the first approach would not provide a suitable solution "because it attempts to replace the "invisible hand" of Adam Smith with the "invisible fist" of government." (page 1246) Cooperatives were a common farmer response to weak bargaining positions but he resisted granting them more favorable treatment because "... greater insulation of

cooperatives' activities form antitrust statues, for example, serve no general social ends and are not economically justified." (page 1246) He preferred "More vigorous antitrust policy, [because] while slow, offers the basic and most effective approach to redressing market power." (page 1246) Clearly, over the forty years since he wrote his conclusions, farmers have had more success with institutions designed to limit the power of buyers than from an aggressive antitrust policy to preserve competitive markets in which farmers could sell. Cooperatives, bargaining associations, marketing orders, and even electronic auctions have been used to improve farmers' economic power imbalance with buyers.

The structural data on food and tobacco processing industries given in **Table 4** fail to provide the necessary information to study oligopsony. In addition to problems with the geographic scope of an industry, the Census data, especially at the 4-digit industry level, often are too broad to reflect a properly defined market on the basis of product scope. Of the 53 industries given in **Table 4**, several are well-defined product markets (e.g., butter or malt beverages) but others are much too broad (e.g., canned fruits and vegetables or dehydrated fruits and vegetables) and essentially all are too broad for input markets. As Rogers and Sexton noted "although there were 81 firms in canned fruits in 1987, only 5 and 11 processed cranberries and olives, respectively. Thus, whereas canned fruits may represent a relevant output market class, it is far too broad for analysis of competition in the raw product markets because the vast majority of fruit processors do not compete, for example, for olives or for cranberries." Needed data are not readily available, and the situation is getting worse as public information diminishes. In addition, larger firms are reconsidering the strategic tradeoffs of sharing proprietary firm data with industry-wide data collection efforts. The strategic value of asymmetrically held information increases as a firm's market share increases.

Economists have not given sufficient attention to oligopsony issues. As Scherer and Ross state "A quantitative picture of how much buyer concentration exists is difficult to secure, for there are no statistical series analogous to the abundant data on seller concentration. An impressionistic view suggests that concentration on the buyers' side is generally more modest than concentration on the sellers' side, although appreciable pockets of monopsony or oligopsony power...can be found (page 517)." Agriculture is definitely one of those pockets. Rogers and Sexton examined the unique characteristics of agricultural markets (bulky and/or perishable product, specialized processing needs with little to no input substitution, specialized investments in sunk assets, and cooperatives, bargaining associations or other institutions of seller power exist or could exist) and argue for agricultural economists to recognize the dramatic influence these unique characteristics have on assessments of market power.

To study buyer concentration is to study vertical marketing systems, or what has been called subsector analysis. Agricultural economists have a rich tradition of doing such studies, usually as case studies of a particular agricultural commodity (for examples, see Marion, Chapter 3). The data requirements of these studies are dramatic and offer a unique insight into the how farmers, intermediaries, institutions, processors, distributors, and retailers accomplish the task of moving an agricultural commodity from production to consumption. Over time the profession has produced a vast array of such studies, but they tend to become outdated and few unambiguous performance conclusions can be drawn from them. Nevertheless, these studies provide one of the best vantage points to examine concerns over buyer concentration as they usually track product flows from farmer to all final consumption points and often

give concentration information on the number and size distribution of buyers along the way.

These vertical studies must address the other critical issue involved in buyer (and seller) concentration, namely market definition. Defining a market is no easy task, even for a market economist. Both product and geographic scopes must be considered, and the importance of spatial economics becomes apparent. It is not uncommon for a commodity to move from a local geographic market at the original procurement stage (grain delivered to the rural elevator) to a global market definition at the later stages of production (grain exports). Merely an examination of the current economic players and the regional flows of products is not sufficient as economists are concerned about supply responses induced by price changes. The merger guidelines use a theoretical notion in which a hypothetical monopolist (monopsonist) would impose a "small but significant and nontransitory" price increase. In practice, a five percent increase was often used but the 1992 guidelines backed away from stating any specific amount.

The few general economists that have attempted an empirical study of buyer concentration (e.g., Lustgarten) have not addressed these issues. They usually estimate buyer concentration from the level of national seller concentration of the manufacturing industries. When a manufacturing industry buys the supplying industry's total output, then the seller concentration does provide the degree of buyer concentration, if and only if, the procurement market is national as well. This is not the case in much of agriculture. Also, seldom does a manufacturing industry buy the entire supplying industry's output, although this is common in agriculture. When an industry is not the exclusive user of a supplying industry's output, then the national seller concentration ratios are weighted by the amount these industries buy from each of the supplying industries. The weights are taken from the national input-output tables. Another major data problem emerges here in that these industry definitions are much too broad reflecting less exclusive use than actually exists. When one examines the 1982 Input-Output tables to discover the extent of the total supply of an agricultural commodity (e.g., processing tomatoes) used by a food processing industry, say canned fruits and vegetables, one finds that all agricultural vegetables are combined into a single industry.

The data problems alone limit the number of empirical studies. Despite the limited number of studies, some information on buyer concentration faced by farmers is publicly available and is suggestive of oligopsony. Although far from conclusive, firm counts and concentration data remain useful as a first step in determining where additional information is required. Few market power problems arise where numerous, similarly sized firms compete. However, even a small number of buyers (sellers) is not sufficient to conclude that market power exists. Conditions of entry, and even just the credible threat of entry, can restrain any attempts to profit from any market power that might be possible in the short run. Nevertheless, just as the merger guidelines use the H-index as a rough guide as to which mergers will be further examined, concentration data can be used to highlight potential areas warranting further study.

The Census of Manufacturers provides most of the public data used by economists studying the manufacturing sector, including food and tobacco processing. In addition, much detailed data on the livestock related industries are available from USDA. The most common concentration data are given every five years in a special report of the Census of Manufacturers, however we still await the 1997 concentration data, which now uses a new coding system (NAIC) that will complicate comparisons over

time but will allow comparisons across North America. These data give the number of companies, establishments and the national concentration ratios for the 4, 8, 20 and 50 largest firms in an industry. The narrowest Census data definition is the 7-digit product level and at this level the only relevant data are the number of companies that had value-of-shipments of at least $100,000 for that product in the year. The Census also provides industry (4-digit) data at the State level, and even at the county level, but the extent of the data falls off dramatically as you leave the national level. For example, the State level does not give company counts, only establishment counts. In addition, there are no data on size distribution of the establishments other than a separate count for those establishments with more than 20 employees.

Although **Table 4** is woefully inadequate for questions related to oligopsony, it does suggest that farmers selling to the processing industries face fewer and more dominant firms buying their output. Decreases in firm numbers and increases in concentration ratios were common over time. The wine industry (SIC 2084) was the only industry to show a large increase in the number of firms (+339), but the industry CR4 rose from 1987 to 1992. This is the only industry that gave farmers substantially more buyers in 1992 than existed in 1967. Canned specialties also posted an increase in company numbers (+50) with an unchanged CR4, but it is not an important industry to farmers. The cookies and crackers industry did increase by 88 firms with a small decrease its CR4, but this is not an industry of direct importance to farmers either. The variable, ag input share, measures the extent the industry relies on U.S. farm output for its input--ranging from 0% for no U.S. agricultural inputs are purchased by the processing industry to 88% in the milled rice industry (in the case of coffee, it was assigned 0% even though a small amount of coffee is grown in Hawaii).

As can be seen by inspection, there is an inverse correlation between change in company numbers and concentration change. Only in a few cases does this not hold. The most dramatic case was in the beer industry where company counts increased, yet its CR4 jumped by 50 percentage points. The end result was that farmers and consumers face more concentrated processing industries, the only other remedy available to them was to seek institutional arrangements to offset any power imbalance. Cooperatives allow farmers to integrate forward into processing and avoid having to sell to a firm that has monopsonistic power.

The immense size of processors has always concerned farmers who feared the processors would exploit their bargaining power and pay farmers less than fair market value for their crops. Such fears led to agricultural cooperatives and the Capper-Volstead Act of 1922. Both economic theory (e.g., Cotterill) and empirical studies (e.g., Rogers and Petraglia), conclude that open membership cooperatives can negate market power imperfections and hence benefit both farmers and consumers.

In **Table 4** the share of an industry's shipments controlled for by the 100 largest cooperatives ranges from a high of 63% in the butter industry to several industries without any cooperatives, and averages 5.4% for all of food and tobacco processing. Farmers selling through their marketing cooperative do not worry about the concentration in the processing market. The second highest cooperative share is in rice milling (44%) and several more industries have a cooperative share exceeding 10%, especially in the dairy industries. Much of the cooperative involvement in forward integration of their farmer members output is

lost when just food processing industries are examined because cooperatives have a major presence in the first handler markets that the Census classifies outside of processing. For example, the 100 largest cooperatives accounted for 5.7% of the buying and marketing of farm-product raw materials (SIC 515), slightly more than their involvement in food and tobacco processing (SIC 20+21). Although there were no cooperatives with establishments primary to meatpacking in 1987, they did account for 8.9% of all buying and marketing of livestock, including cattle, hogs, and sheep (SIC 5154). Similarly, only one cooperative had an establishment primary to flour milling and the cooperative share was just one percent, but the cooperative share of buying and marketing grain, dry beans, and soybeans (SIC 5153) including country grain elevators was 4.2%.

There is a statistically significant positive correlation between how important an industry is to farmers, as measured by ag input share, and the percentage share held by cooperatives. Indeed, in a simple regression model explaining percentage share held by the 100 largest cooperatives, the importance of the farm input is positive and significant and the ratio of an industry's value-added to value-of-shipments is negative and significant. However, history does matter and in several industries where one would expect a strong cooperative presence, none was found. Whereas in almost all of the dairy industries cooperatives have a large presence. The importance of history is perhaps most apparent in the tobacco stemming and redrying industry. This industry has nearly 50% of its cost of materials attributed to tobacco but no cooperatives are present. Campbell provides a history of an attempt by tobacco growers to form a cooperative to challenge the "Tobacco Trust" put together by the American Tobacco Company (ATC) around the turn of the century. The tobacco farmers were being offered prices below the cost of production as there were no buyers competing with ATC or its purchasing agents. The cooperative organized nearly a third of the growers in the Kentucky/Tennessee region known as the black patch by 1908 but failed two years later. The failure was attributed to poor organization and leadership and attacks from ATC.

Most researchers have had to abandon Census data for studying oligopsony. Within the livestock industries researchers have used either the USDA data from inspection records or from Packers and Stockyards. Others seeking even more disaggregated data, or studying other industries, have turned to industry supplied data, either provided by industry cooperation or authorized by governmental agencies charged with oversight responsibilities. The researchers need for detailed firm data is seldom realized and most studies must make do with less than ideal data. The meat industries have been the subject of the most recent studies and even here where the data are more detailed and available, the research has reached inconclusive results, which many analysts believe are at least partially attributable to imperfect data.

Competitive Strategies in Oligopoly Markets

The concentration data of **Table 4** are more suited to analysis of oligopoly than oligopsony. In oligopolies, firms often turn to nonprice strategies to enhance their competitive position. Food processors have long used branded products and a pull marketing strategy where they create consumer demand for their products and hence retailers are obliged to carry the products or lose sales. New products with strong media advertising support, especially television, are central to this strategy. Other

marketing strategies (e.g., coupons) are often correlated with new products and advertising efforts (Connor et. al.). New product introductions rose from 4,540 items in 1983 to a high of nearly 17,000 in 1995 and fell back to 12,400 items in 1997 (**Table 5**). Most, by far the majority, do not represent truly new products but variations on existing products. Nevertheless, most new products fail in the marketplace, underscoring both the difficulty of knowing what the consumer wants and the wastefulness of new product launches. Even Coca-Cola with its huge marketing muscle misfired with its New Coke. Consumers loudly voiced their preference for the original and hence we now have Coke Classic and New Coke with the former far outselling the newer product.

Table 5. New Food Product Introductions, 1983-1997

Food Category	1983	1985	1987	1989	1991	1993	1995	1997
Baby foods	24	14	10	53	95	7	61	53
Bakery foods	515	553	931	1,155	1,631	1,420	1,855	1,200
Baking ingredients	134	142	157	233	335	383	577	422
Beverages	506	625	832	913	1,367	1,842	2,854	1,606
Breakfast cereals	34	56	92	118	104	99	128	83
Condiments	906	1,146	1,367	1,355	1,885	2,043	2,462	2,505
Candy, gum, & snacks	775	904	1,145	1,701	2,787	3,147	3,698	2,631
Dairy products	486	671	1,132	1,348	1,111	1,099	1,614	862
Desserts	37	62	56	69	124	158	125	109
Entrées	319	409	691	694	808	631	748	629
Fruits and vegetables	126	195	185	214	356	407	545	405
Pet foods	62	103	82	126	202	276	174	251
Processed meats	348	383	581	509	798	453	790	672
Side dishes	133	187	435	489	530	680	940	678
Soups	135	167	170	215	265	248	292	292
Total Food	4,540	5,617	7,866	9,192	12,398	12,893	16,863	12,398

Source: Gorman's New Product News, reprinted in Food Institute Report, January 21, 1989, page 7 and February 8, 1999, page 3.

Food processors outspend all other stages of the vertical marketing system advertising their products. In 1997, they accounted for over 65% of all media advertising in the food system (**Table 6**). Only restaurants, especially fast food, also spend large amounts on advertising, with a 27% share of the total. The bulk of the $55 million spent in farm related expenditures was for farm chemicals and pest controls which were advertised by the large chemical companies targeting farmers as consumers of their chemical products. Media advertising accounts for somewhere between a fourth and a third of marketing dollars spent by processors. Within the food system, advertising created and maintained product differentiation, provides protection from new entrants and inroads from smaller rivals. Oligopolists often prefer to compete with their rivals in nonprice ways. Advertising and new product rivalry are perfectly suited to this strategy as it allows competition among the few in a manner that collectively erects barriers to entry to others not involved in the marketing fray. The cola wars are often mentioned as an example of the intense competition in the soft drinks industry but a former President of Pepsi once commented that such struggles did not involve "some gladiatorial contest where one of us has to leave on a stretcher. We're both winning."(Sculey).

Table 6. Total Measured Media U.S. Advertising Spending by Category--1997 and 1996

Category	1997	1996	% Change
	Millions $		Percentage Change
Total farm related advertising	55.4	49.2	12.6
Food and food products	3,361.6	3,209.6	4.7
Beverages	1,320.7	1,324.5	-0.3
Beer, wine and liquor	1,089.2	1,019.5	6.8
Candy and snacks	1,094.4	965.7	13.3
Pet foods and supplies	360.1	317.1	13.6
Cigarettes, cigars and tobacco	455.1	488.3	-6.8
Total food and tobacco processing	7,681.1	7,324.7	4.9
Restaurants and fast food	3,147.1	2,960.8	6.3
Food and liquor retail	859.6	804.1	6.9
Food and liquor–direct mail	19.8	14.2	39.4
Total food and tobacco related	11,763.0	11,153.0	5.5
Total–U.S. media advertising	73,214.7	66,711.0	9.7

Source: Competitive Media Reporting.

Media advertising is not for the cash-starved startup company but is standard operating procedure among the largest food and tobacco processors. Philip Morris, the number one food and tobacco advertiser, spent over a billion dollars promoting its brands that range across the entire food store including Miller beer, Marlboro cigarettes, Kraft cheese, General Foods Post cereals, Oscar Mayer hot dogs and several other major brands. Of the 16,000 food and tobacco processing firms, the top 100 advertisers accounted for 96.4% of media advertising and the top 8 alone accounted for over 50% in 1992 (**Table 7**). The vast majority of the remaining 15,900 food firms use media advertising minimally or resort to other marketing tactics. Since advertising-created-and-maintained product differentiation is the major advantage in the food system, these firms are at disadvantage and are left to compete primarily on price and efficiency and the rare truly new product that captures consumer interest. The concentration of advertising expenditures has risen sharply from 1967 to 1992, the last year the data were analyzed, with the four largest advertisers increasing their share from 19.4% in 1967 to 36.9% in 1992.

Table 7. Concentration of Advertising Expenditures in Food and Tobacco Processing 1967 to 1992

	1967	1982	1987	1992
		percent		
Top 4	19.4	26.8	32.8	36.9
Top 8	29.9	39.3	47.3	51.0
Top 20	53.4	65.7	72.1	75.3
Top 50	78.1	88.7	90.6	91.1
Top 100	90.5	95.6	96.2	96.4

Note: Excludes advertising by associations, boards, and governments.

Source: Competitive Media Reporting, Leading National Advertisers, Inc., data analyzed by Richard Rogers and Dennis West, Department of Resource Economics, University of Massachusetts—Amherst.

Concentration Change in Food Processing

Concentration in food processing markets is of interest to both farmers who must sell to food processors and to consumers who ultimately purchase the processed food products. Only food retailers have grown to challenge the market leadership of the food processors. The analysis of concentration data in the remainder of this paper focuses on output markets and fails to provide much guidance for oligopsony issues, other than by providing a crude measure: if output markets are concentrated, then the agricultural input markets certainly are. The available concentration data limit us to examining the four-firm concentration ratio as it is the most accepted and traditional measure of market concentration. The Hirshman-Herfindalh is often preferred by economists, usually for its nice algebraic properties in theoretical derivations, but the two measures are highly correlated especially at CR4s under 50. With the recently acquired 1992 product class concentration data (appendix a1), we can examine CR4s over the 1958 to 1992 time period in **table 8** (and **Figure 4**) for 76 well-defined economic markets. In 1987, there were 160 food and tobacco product classes, but both by design to improve market definition (e.g., use the four-digit beer industry as opposed to the five-digit product classes and combine cane and beet sugar industries) and by constraint (e.g., changes in definitions over time) we lose many observations over the time period (manufactured ice was also removed, but with no effect on the trends). There is a tradeoff between the time period and the loss of observations, but here we side with the longer time period. Later we will examine more markets over a shorter the time period.

Overall, the mean CR4 for these 76 food and tobacco markets was nearly 48 in 1958 and rose to 62.5 in 1992. However, once the observations are segmented by the degree of product differentiation, measured by use of media advertising, several patterns emerge. First, among consumer goods product classes, there is a positive association with the level of concentration and the degree of advertising use that is true in every year examined. Second, only in the high advertising use group did the mean CR4 increase in every time period, rising from 61.7 in 1958 to 71.9 in 1992. In both the low and medium use groups, mean CR4 held nearly steady, or decreased, in the early decade before beginning an unbroken increase. This pattern is most apparent in the low advertising use group, as its mean CR4 went from 38 in 1958 to about 40 in 1977, but then increased to 54.8 in 1992. Seven of the 17 observations are from the meat industries, which increased rapidly in concentration during this period. In fact, 1977 appears an important date in the break down of nearly constant mean concentration in this group. The medium advertising use group also displayed this tendency but not as dramatically, whereas the highest use group showed the reverse as it posted larger increases in the 1958 to 1977 period than in the 1977 to 1992 period.

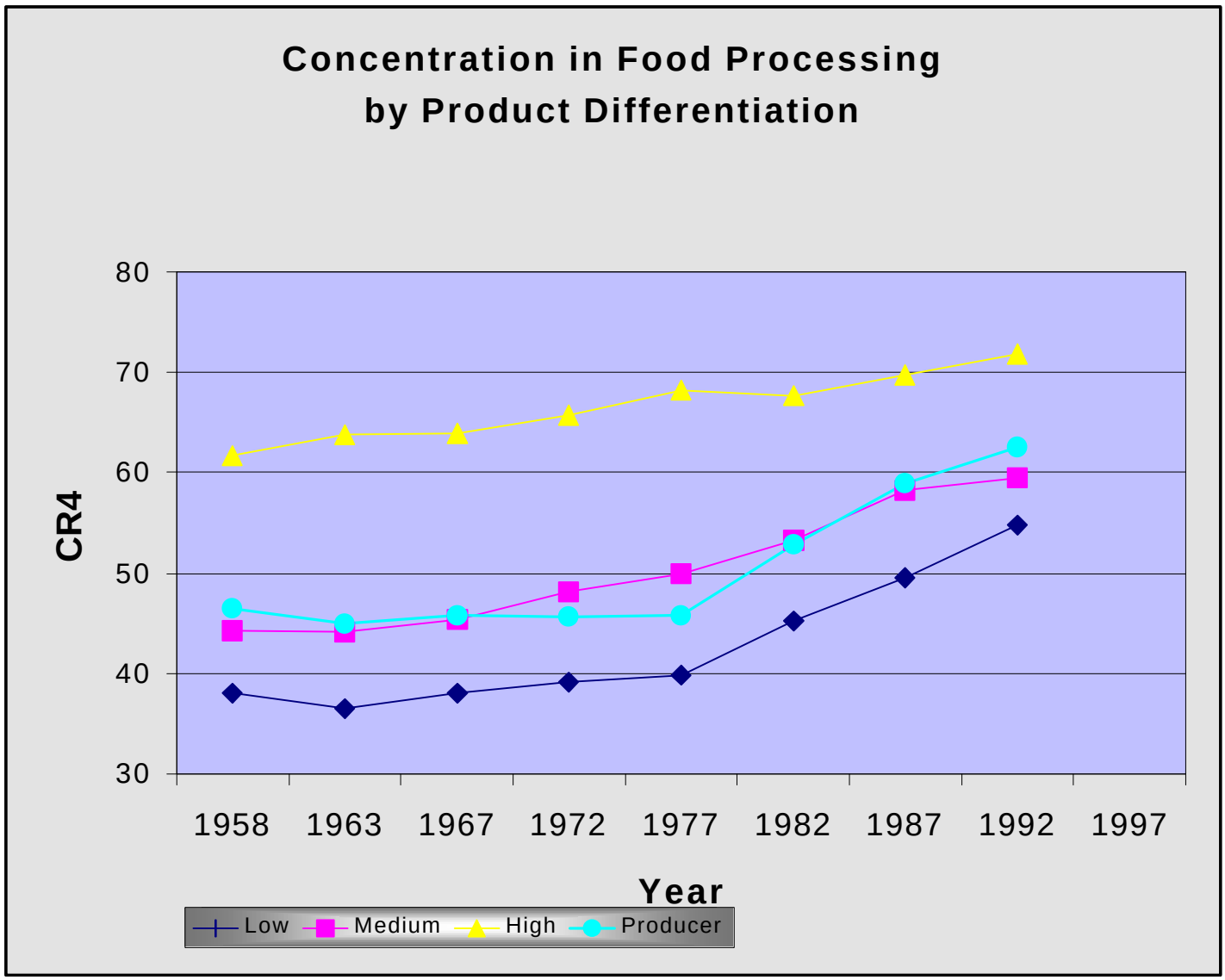
The producer goods product classes followed the patterned discussed for the low advertising use group and actually declined in mean CR4 from 1958 to 1977, from 46.5 to 45.8, but then posted a substantial increase in mean concentration from 1977 to 1992, rising from 45.8 to 62.6. Most of these product classes are from the milling and fats and oils industries.

Table 8. Average Four-Firm Concentration Ratios by Product Differentiation, 76 U.S. Food and Tobacco Product Classes, 1958 to 1992

Year	All Product Classes	Producer Goods	Consumer Goods Product Classes		
			Low Advertising	Medium Advertising	High Advertising
	n = 76	n = 24	n = 17	n = 16	n = 19
1958	47.9	46.5	38.0	44.3	61.7
1963	47.6	45.0	36.5	44.1	63.7
1967	48.5	45.8	38.0	45.4	63.9
1972	49.8	45.7	39.1	48.2	65.7
1977	50.9	45.8	39.8	49.9	68.2
1982	54.9	52.8	45.2	53.3	67.7
1987	59.4	59.0	49.5	58.2	69.7
1992	62.5	62.6	54.8	59.6	71.9
Change:					
1958-1977	3.0	-0.8	1.8	5.7	6.5
1977-1992	11.6	16.8	15.0	9.6	3.7

Source: Census of Manufacturing, including Special Tabulations.

Figure 4.



Source: Table 8.

Sutton's Sunk Costs and Market Structure

Sutton attempted to close the gap between the inadequate S-C-P paradigm and the game theory approach to the determination of industrial structure. The S-C-P school had been discredited as simplistic and ignoring feedback from performance and conduct to structure. The game theorists gave us many models but few robust conclusions as the game's details led to numerous outcomes, which hinged on the model's specifications. Sutton's approach was to seek broad conclusions without sacrificing theoretical rigor or prior empirical regularities found in the literature. Briefly, his model is a two-stage game, where in stage 1 a firm decides whether to enter the market. If a firm enters it must pay a sunk cost, ó, and then in stage 2 the firm faces some form of price competition that can be either soft (price exceeds marginal cost) or hard (price at marginal cost). The sunk costs can either be exogenous as in the case where a firm must acknowledge current scale economies and build or buy a plant of minimum efficient size. This cost must be borne by all entrants and is exogenously determined by technology. Additionally, firms can chose to invest in advertising to increase consumer's willingness to pay for their products and hence this sunk cost is endogenously determined as firms make this choice: to advertise or not to advertise.

This distinction between the sunk costs being exogenously or endogenously determined is central to Sutton's theory in explaining industry concentration. In the food industries, the use of advertising is critical to this classification as those industries that produce homogenous goods (e.g., sugar) unaided by consumer advertising face only the exogenous sunk cost of having a plant of minimum efficient size, whereas in industries where advertising is used (e.g., breakfast cereals) firms must choose a level of advertising and hence face an endogenous sunk cost.

Sutton lays out his full theory in Chapters 2 and 3 of his book and then in Chapters 4 and 5 he tests his general conclusions using data from the six largest Western economies, 20 food industries, and a reference year of 1986 (although much of the data are from the mid1970s due to availability). To his credit, he is very careful in selecting industries that allow comparisons across the six countries. He is equally deliberate in his choice of empirical measures for his theoretical variables. He uses the CR4 for his concentration measure, although he also uses a logit transformation on CR4 to address the limits problem. For the setup cost, ó, that minimal sunk cost all firms must pay to enter an industry, he uses the median plant size relative to total market size, called MES in the literature (see Connor et. al. or Sutton pages 94 to 99, but Sutton takes his MES estimates from Connor et. al.). Sutton is well aware of the limitations of this measure, including the most troubling fact that large firms in concentrated industries have large plants and they need not bear much resemblance to a true minimum efficient size, given that average cost curves are likely to decline to a true MES but then remain constant over a wide range of outputs.

Unlike Sutton, I am less careful in my inclusion of industries in this study. I have made a career of arguing for researchers to follow his attention to detail but here I have elected to go with my critics who contend that my selections reflect my biases and foretell the results. I have used all 4-digit food and tobacco industries in each Census year from 1972 to 1992, with the exception of manufactured ice (SIC 2097) and miscellaneous foods (SIC 2099). I examine only the U.S.

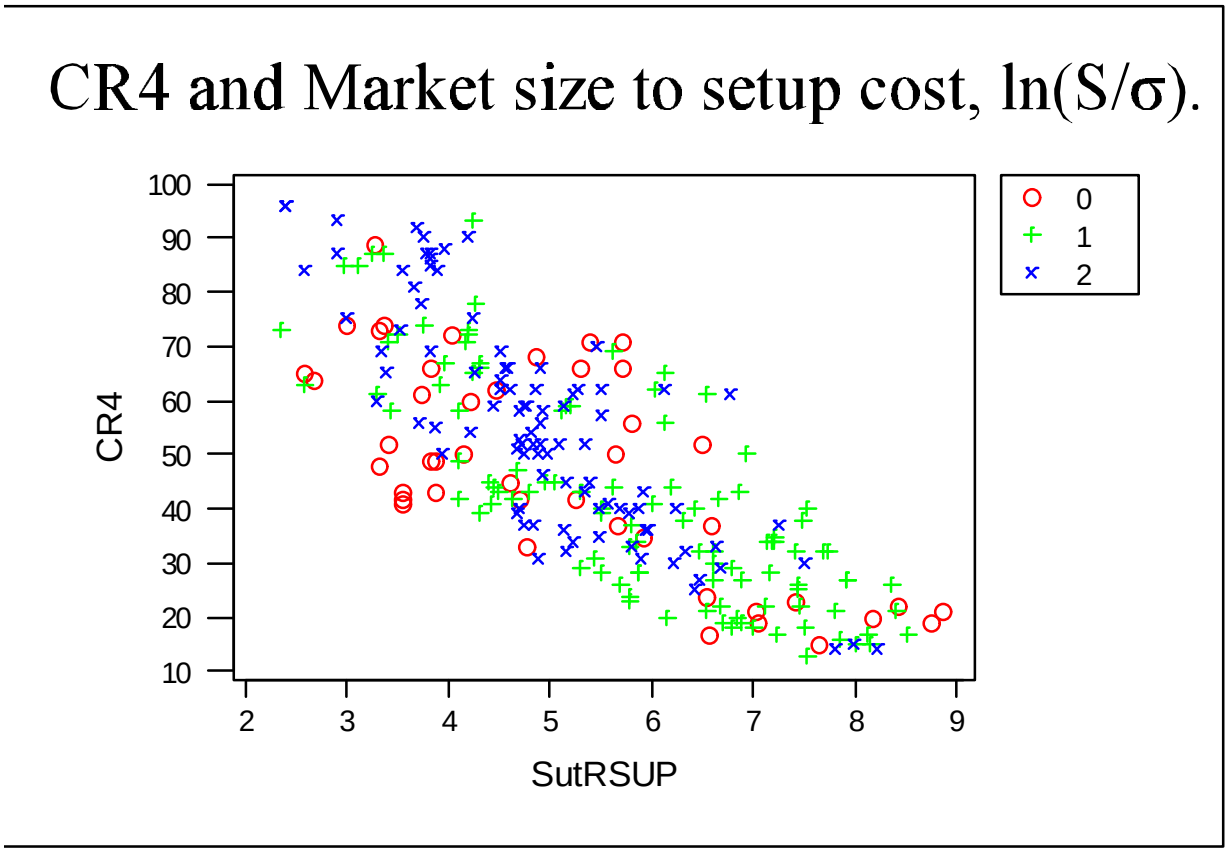
economy and hence lose much of Sutton's ability to test his full theory because I lack observations of the same market across different economies that vary by size. However, the rest of my analysis attempts to follow Sutton's advice. I use the CR4 for concentration and I also used the logit transformation, but since it rarely produced any different results, I report only results with CR4 in this paper. I used the industry value of shipments, or its natural log, as a measure of market size. I calculated MES from Census data for each industry in each Census year following the methods described in Connor et. al.. I calculated capital-output ratios (KO) for each industry in each year as well. I was then able to calculate an industry's relative setup cost as MES * KO (or in Sutton's notation ó /S). Lastly, I matched media advertising data from Competitive Media to each industry to create an advertising-to-sales ratio for each industry in each Census year. I pooled all years of data to form one data set with 247 observations on roughly 50 industries over five Census years (checks on each year revealed no significant differences, other than an increase in base concentration over time). Those tasks alone were substantial undertakings.

Sutton notes three empirical regularities from the past literature, which he used as checks to his results. The first observation dealt with cross-industry studies finding some support, although some argue it's weak support, of a negative relationship between market size and market structure. Sutton notes that this deals with scale economies (MES levels) and market size. His results are in his words "consistent with the earlier findings, while leading to a different specification and a sharper empirical result (p. 124)." Sutton argues against pooling homogenous goods industries and advertising intensive industries given the different expectations regarding the relationship between relative market setup costs and concentration. He states "If such pooling is employed, however, the theory predicts that this will lead to a weaker but still negative relationship between concentration and the ratio of MES to market size (p. 124)."

My results do not show this difference between homogenous goods industries and advertising intensive industries. I used the advertising-to-sales ratio to classify industries into three groups. Group 1 was the homogenous goods industries, which included 45 observations each with an A/S ratio of less than 0.10% (most were exactly zero). Group 2 was an in-between group with 105 observations where A/S ratios were from 0.10% to 1.50%, and group 3 were the most intensive advertisers, 97 observations, with A/S exceeding 1.50%. (I also used just two groups with the split on a A/S ratio of 0.25%, but the results were similar and the three groups allow for a stronger testing of the homogenous goods case and the advertising-intensive group.) As can be seen in the figure below, no difference appears between the relationship between concentration and relative setup costs for these three groups. This result will repeat below in a more formal testing of the relationship between concentration and setup costs.

Figure 5.

Notes: 0 is homogenous goods, 1 is the intermediate group, and 2 is the advertising intensive



group. SutRSUP is Sutton's measure of market size to setup cost ratio, or ln(S/ó).

Sutton's second noted empirical regularity is the finding that median plant size (and firm size) increases with the size of a market. Although Sutton's theory does not address multiple plant firms, his theory does predict this outcome. As a simple test, I regressed median plant size on a constant, the natural log of industry value of shipments (S), A/S ratio, capital-output ratio (KO), and a dummy (NL) for a local or regional industry (e.g., milk or bread). The results were:

medplant = - 548 + 79.0 S + 12.8 A/S + 0.784 KO - 178 NL ; R^2 = .188

All estimated coefficients except for KO were statistically significant at the 1% level and the results support the observed regularity. It is of interest why an industry's A/S ratio positively affects a median plant size, given the hope that MES is dependent on technology.

It is Sutton's last empirical observation that is of the most interest to this paper. As he says (p. 123-4) "A number of authors have attempted to account for cross-industry differences in concentration within a single country by regressing some measure of concentration on (a) the degree of scale economies, as measured by MES estimates, (b) market size, (c) some measure of advertising intensity (usually the advertising-to-sales ratio), and (d) some measure of R & D intensity. Studies of this kind have tended to find that concentration is related positively to MES and negatively to market size." He notes the results on the advertising variable are mixed, with some authors finding a positive result (myself included) and others finding an insignificant result.

Under Sutton's theory, a regression of this form is misspecified. Sutton notes that the original criticism of such a regression hinged on the econometric problem of simultaneous equation bias since advertising levels were not exogenous. Sutton finds this criticism to miss the main problem, which is not simultaneity but a switch in regime problem–the relationship is fundamentally different between homogeneous goods industries and advertising intensive industries. Sutton (pp. 125-6) explains his logic as follows:

> "Suppose, consistent with the theory, that a negative relationship exists between concentration and market size for the homogenous goods group, and a null relationship exists for the advertising-intensive group. Suppose, again consistent with the theory, that the mean level of concentration within the advertising-intensive group is higher than that of the homogeneous goods group. Then if concentration is regressed on the market size/setup cost ratio and the level of advertising intensity, for the pooled sample, the present theory predicts a negative coefficient on the market size/setup cost ratio and a *positive* coefficient on the advertising-intensity level variable. (A full explanation of this point is set out in the annex at the end of the chapter.) Hence, the theory provides an explanation of why such traditional specifications have occasionally found a significant positive coefficient on the advertising variable, while also suggesting that such a specification is inappropriate."

Empirical Results based on Sutton's Theory

My empirical results fail to support his first supposition since the negative relationship between concentration and market size is found for both the homogenous goods group and for the advertising-intensive group. My results do support the second supposition as concentration, on average, is still higher in the advertising-intensive group, but the difference has narrowed over time. In brief, I find no reason for the relationship between market concentration and relative setup costs to differ between those industries producing homogeneous goods and those industries where advertising is intensively used. My analysis began with separating all my observations into two groups: a homogeneous goods group with industry A/S ratios of 0.25% or less (n = 72) and the remainder belonging to the advertising intensive group (n= 175). I preformed all the analysis given below on these two groups, but found no support for a difference in the relationship between concentration and relative setup costs between groups. To enhance the difference between the homogenous goods group and the advertising intensive group, I segmented the full sample into three groups as described above with the middle group representing industries which were low users of advertising, with A/S ratios from 0.10% to 1.50%. The table below gives the means for key variables based on these groups. The mean CR4 is higher in the high advertising group than in the homogeneous group as Sutton expected.

Table 9. Means for Selected Variables

Variable	Full sample	Homogenous goods	Low advertising	High advertising
sample size, n	247	45	105	97
CR4 (%)	48.4	47.8	42.0	55.5
Value of shipments ($M)	5226	3137	6793	4500
MES (%)	3.8	3.3	3.3	4.6
KO (%)	29.9	40.8	25.1	30.1
Setup Cost: ln(S/ó)	5.32	5.11	5.82	4.89
A/S (%)	1.9	0.0	0.6	4.2

Note: See text for descriptions of variables and how groups were formed.

I began my analysis with a traditional cross-industry regression, where CR4 (or the logit transformation, but those results are not presented here as they are nearly identical) is regressed on the traditional variables of market size, MES, KO, A/S, and I added a national-local dummy

and a time trend variable as well (**Table 10**). There are five non-national markets among the food and tobacco industries and thus their concentration level are understated by the Census (those industries are: ice cream, milk, feeds, bread, and soft drink bottling). To account for the 5 Census years, I used a time trend (just the year; 72, 77, 82, 87, 92) or dummies for each year of the study.

The first regression used the full sample and the results are consistent with expectations and previous empirical work, with the exception of market size. Size was not negatively, but positively associated with concentration. The other key variables, MES, KO, and A/S showed a strong positive relationship with CR4. The regional dummy suggests that national CR4 figures understate CR4 in these markets by around 18 percentage points. The time trend, Year, was positive and weakly significant (when yearly dummies were used instead of Year, only the 92 dummy reached positive significance, but each year's dummy variable had a larger estimated coefficient, reflecting advancing concentration over time). Overall, the model does a fine job explaining the variation in industrial concentration with an R^2 of 61.5%.

Sutton's main concern is the pooling of distinctly different types of industries in such regressions. Thus, we estimate the same traditional model with each of the three groups of industries: from homogeneous goods industries to high-intensity advertising industries. For the homogeneous group, the A/S ratio was not used since it is constrained to zero, but the other results are very similar, with the exception of insignificance on the estimated coefficient for KO and the greater magnitude of the estimated coefficient on MES. Market size still retains a perverse positive estimated coefficient. Similar findings also emerge from the low intensity group, but market size becomes insignificant and the estimated coefficient on A/S is much larger, reflecting the fact that the range of this variable is between .10% and 1.50%. Consider the results from the high advertising group. This group, according to Sutton, should have results markedly different from the homogeneous group, but again remarkable similarity exists, even given the positive effect of A/S for this group. For this group of high advertisers, I repeated the basic model but allowed for a non-linear effect from A/S since it varied from 1.5% to 18.0%. There was support for a non-linear effect from A/S, which is consistent with much previous literature and is not at odds with Sutton's theory.

The above results fail to support the main idea that there should be a fundamental difference in the relationship between sunk costs in homogeneous industries and in advertising intensive industries. Those results, however, are based on a traditional regression model and I now turn to using Sutton's relative setup cost variable (ln(S/ó)), which replaces market size, MES, and KO in the model. In Sutton's annex to chapter 5 (page 127), he shows why such a model is misspecified and the resulting influences on such a model's results if applied to a pooled sample will be to bias the estimated coefficient on the relative market setup cost variable upward (toward zero) and the estimated coefficient on A/S is biased upward away from zero.

I estimated his "misspecified" model to the full sample and the results are shown in the first column of results in **table 11.** Every estimated coefficient is statistically significant and compares well to the traditional model in table 10, except the regional dummy is not significant. According to Sutton, this model's estimated coefficients on setup cost and A/S are biased due to the inappropriate pooling. To check this, I estimated his true model in his annex by including an interaction variable between setup cost and whether the industry was a homogenous goods

industry. Rewriting his true model here: $CR4_i = \beta_0 + \beta_1 \tilde{S}_i + \beta_2 \alpha_i \tilde{S}_i + \beta_3 (A/S)_i + \varepsilon_i$ where: $\tilde{S}$ is the market size/setup cost ratio or here ln(S/ó), $á_i = 0$ if the industry is a homogeneous goods industry and 1 if A/S>0. Sutton expected $â_2 = -â_1 > 0$ and $â_3 = 0$. This model is estimated in the second column of **table 11**, but the results show no support for this expectation. In fact, it suggests there is no difference in the relationship between concentration and relative setup costs for these two industry groups.

To further test this idea, I estimated the basic Sutton model on the three subgroups of data. First, the homogeneous group, which supported the negative relationship between relative setup costs and concentration in these nonadvertising industries. The results for the low and the high advertising groups not only fail to suggest a null relationship between setup costs and concentration in these advertising industries but the direction of the difference in the estimated coefficient is not toward zero but an even stronger negative effect. The estimated effect from A/S is insignificant in the low advertising group, but returns to significance in the high advertising group. There is some support that the relationship between A/S and CR4 is nonlinear as well.

In short, my empirical results do not find any reason not to pool the homogeneous goods industries with the advertising industries. We are left with the old criticism of these models having simultaneous bias problems, but not a misspecification from inappropriate pooling.

Table 10. **OLS Regression Results for Typical Cross-Industry Study explaining the Level of Concentration (CR4)**

Variable	Full sample n=247	Homogenous goods, n=45	Low advertising, n=105	High advertising, n=97	High advertising, n=97
constant	-6.35 (-0.63)	-30.10 (-1.31)	-9.88 (-0.61)	-6.86 (-0.49)	-22.59 (-1.57)
Size, S (ln VOS)	2.115 (2.10)	6.522 (2.26)	0.036 (0.03)	6.500 (3.95)	5.843 (3.69)
MES	2.369 (10.82)	4.272 (4.43)	2.479 (8.58)	2.349 (7.48)	2.581 (8.37)
KO	0.262 (5.21)	0.039 (0.46)	0.398 (4.91)	0.283 (2.16)	0.297 (2.37)
A/S	1.50 (4.55)	----	6.65 (2.37)	1.20 (2.62)	4.59 (3.97)
NL (=1 for non-national market)	-17.94 (-6.03)	-26.54 (-3.63)	-10.41 (-2.75)	-30.94 (-5.94)	-27.89 (-5.52)
Year	0.243 (1.76)	0.204 (0.52)	0.370 (1.97)	-0.142 (-0.68)	0.005 (0.02)
$(A/S)^2$					-0.241 (3.17)
R^2	0.615	0.613	0.638	0.693	0.724

[1]Coefficients in parenthesis are t statistics.
*Denotes significance at 5% level.
**Denotes significance at 1% level.

Table 11. **OLS Regression Results for Models using Sutton's Relative Setup Costs to Explain the Level of Concentration (CR4)**

Variable	Full sample n=247	Full sample n=247	Homogenous goods, n=45	Low advertising, n=105	High advertising, n=97	High advertising, n=97
constant	75.38 (7.37)	74.03 (7.16)	32.80 (1.10)	82.46 (5.16)	88.93 (5.54)	82.63 (4.94)
Relative Setup cost (ln(S/ó)	-9.719 (-15.25)	-9.332 (-12.18)	-6.451 (-3.69)	-10.114 (-11.64)	-12.079 (-8.30)	-12.050 (-8.31)
A*(ln(S/ó))		-0.348 (-0.91)				
A/S	1.48 (5.07)	1.57 (5.11)		1.46 (0.53)	1.15 (2.70)	2.55 (2.18)
NL (=1 for non-national market)	-0.995 (-0.34)	-1.275 (-0.43)	-6.829 (-0.76)	-0.963 (-0.25)	1.222 (0.19)	1.697 (0.29)
Year	0.267 (2.44)	0.276 (2.51)	0.595 (1.93)	.212 (1.24)	.254 (1.57)	0.289 (1.77)
$(A/S)^2$						-0.093 (-1.29)
R^2	0.674	0.676	.561	.645	.709	.714

[1]Coefficients in parenthesis are t statistics.
*Denotes significance at 5% level.
**Denotes significance at 1% level.

From Concentration Levels to Concentration Change

The previous work examined concentration levels, rather than concentration change and was based on an analysis of four-digit industries without an attempt to improve the data to comply with well-defined economic markets. A shift to concentration change reduces the risk of misspecified models as some omitted variables may remain constant over time, while we hope that we have included the important variables that drive changes in concentration. Also, every industry has some uniqueness and a change model should help eliminate this difficult to capture aspect. By using product class data from special tabulations of the Census, we should be able to refine the data to more closely align with well-defined economic markets. The hope was to use past special tabs along with a newly purchased special tab to examine the period from 1967 to 1997. Unfortunately, we have not received the full special tabulation of the 1992 Census, although we have received product class concentration ratios, and we have received nothing related to the 1997 special tabulation, which will be hampered by the change from SIC codes to NAIC codes. For now I limit our discussion to an analysis of the 1967 to 1987 period, but examine it as two decades: 1967 to 1977 and 1977 to 1987.

Previous results for the pre-1980 periods found that concentration increases were most often found in industries that used media advertising, especially the more powerful, and newer, television advertising. But somewhere after 1977, many producer goods industries began to concentrate, after years of steady or even falling concentration. Marion and Kim were one of the first to notice this trend. Preston and Connor, Connor, Rogers, and Bhagavan, and Rogers and Tokle also observed this change. A careful look a **Figure 4** will show this post-1977 change among producer goods and even among the less differentiated consumer goods industries.

In addition to an examination of whether the decades posted different concentration change patterns, I want to expand the analysis of concentration change to include the activities of the largest food and tobacco firms, defined as the leading100 food and tobacco firms based on value-added[1]. There are over 16,000 food and tobacco companies, yet aggregate concentration continues to rise to where the top 100 firms control nearly 70% of the sector's value-added. I suggest that these leading firms have played a critical role in changing market concentration as they enter and exit various markets. Clarke and Davis linked the often separated concepts of aggregate and market concentration. They showed that the change in aggregate concentration over time can be explained by changes in market concentration and firm diversification. In U.S. food processing, Ma used the Clark and Davis approach to show that the 28.24% increase in aggregate concentration of the U.S. food manufacturing sector during the period of 1982 to1987 can be separated into a portion, about 45%, attributable to increases in the diversification index and with the remaining 55% attributable to increased market concentration. That is, the increase in aggregate concentration is both linked to the largest firms expanding the number of markets they participate in and the increased market concentration found in the individual markets that comprise the food manufacturing sector.

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[1]Much of this section on concentration change from 1967 to 1987 is from Yu Ma's dissertation. It was the hope of this study to have access to new data from a special tabulation of the 1992 and 1997 Economic Census to update that work, but we await delivery of such data.

Aggregate concentration is a function of both overall firm diversification and market concentration. Now if changes in market concentration are linked to the largest firms' involvement in individual markets, an important link from aggregate concentration to market concentration through large firm involvement in individual industries would be established. Thus, the major objective here is to determine whether or not there exists a link between change in market concentration and change in large firm involvement within that industry. Unlike Sutton, I do not offer a theoretical defense of this idea, but provide an empirical test to determine if the involvement by the sector's largest firms is linked to the changes in market concentration.

No clear causality has been demonstrated, yet a growing amount of evidence suggests that once large firms enter a market they trigger a process that increases market concentration. Typically, when a large firm diversifies through merger, it often buys a single-line company with a respectable market share, at least regionally. Following the merger, earnings from the parent's other product or geographical markets can be used to cross-subsidize the newly acquired firm in an effort to increase its market share. While rival market leaders may have the means to respond and preserve their market shares, the small single-line firms are often forced to merge or go out of business, causing concentration to rise. Two often used examples from the food manufacturing sector are Proctor & Gamble's entrance into coffee and Philip Morris' entrance into the beer industry (for details see Connor et al., pp. 244-265, 1985). Recall the famous business advice by A. Busch to Philip Morris regarding their entrance into the beer industry: “Bring lots of money.”

Large firms' involvement in individual industries may be measured by their collective share of sales held in an industry or by merely a count of the number of these largest firms that participate in an industry. To measure the change in this involvement one can use the difference between the beginning level and ending level of their involvement over a certain period of time. The change can be measured in two ways: either as the change in the share of market sales held by this largest firm group or as the change in the number of the largest firms participating in an industry. The latter measure is the net entry or net exit over a period of time. These two measurements often are not necessarily consistent with each other, as the number of the largest firms may decline, but the remaining largest firms in the industry may account for a larger collective market share, i.e., one measurement is up while another is down. Thus, the collective market share should be a more reliable and a more precise measure of the largest firm involvement than the change in the number of firms, but each measure adds useful information. There is a fundamental difference if one large firm holds a huge share of the market, or if several large firms vie for market leadership.

A review of the literature on the determinants of market concentration has market concentration determined jointly by technology, strategies, and/or a set of stochastic unknown factors. Although debates remain, these are believed to be the fundamental factors behind market concentration. Changes in market concentration should be explained by changes in these same determinants. Specifically, a technological improvement, new form of sales promotion, market growth, or new stochastic factors will lead market concentration to a new equilibrium.

Curry and George (1983) found the earlier empirical studies examined determinants of the level of industry concentration, with more recent literature focusing on changes in concentration. Levy studied past empirical studies and sorted the variables that affect levels as well as changes in market concentration into two groups: scale economies and entry barrier determinants. As he

stated, "According to scale economy explanations, the level of concentration depends on such variables as production economies, capital economies and advertising economies. Explanatory variables suggested by entry barrier explanations are production economies, capital requirements, product differentiation and market growth (which affects ease of entry)" (Levy 1985, p. 56).

Change variables are often considered the theoretically correct form of the independent variables for a concentration change model(Caves and Porter 1980). However, independent variables (such as total advertising intensity level) can affect concentration change through a lagged effect (Caves and Porter 1980; Rogers 1982) and there is great difficulty in knowing when the change took place and whether the researcher has captured the true change. There is no theoretical way to determine how long any lagged effect will be, thus both the level and change in the independent variables should be used in a concentration change model.

The initial concentration ratio (ICR) has been used in most empirical studies and has proven to be one of the most important explanatory variables (Curry and George, 1980). ICR is expected to have a negative effect on concentration change. Economic theory suggests that, ceteris paribus, leading firms in concentrated industries are likely to lose market share over time or to increase less rapidly than less concentrated industries. Although authors expressed concern that the negative relationship is a statistical artifact because of the boundedness of ICR, a review of such concerns and actual tests for statistical bias suggested that no serious problem exists (Rogers, Ch. 2, 1982).

Industrial growth (G) is the most often included independent variable in previous concentration change studies. The sign of G is ambiguous, possibly due to the following opposing arguments: On the one hand, large firms may choose to grow by diversifying into other industries at the expense of growth in their primary industry, while smaller firms may tend to grow in their primary industry. This would result in a decrease in concentration. On the other hand, the dominant firms may have an advantage to outgrow smaller firms in the industry. Sawyer (1971) hypothesized that growth would have a positive effect on concentration change when the number of firms is held constant whereas, if the number of firms increases because of growth, he expected a negative effect. He argues that large firms grow at a faster rate in a particular industry than the smaller firms, which causes the increased concentration. Any firm faces supply and demand situations that affect its ability to grow. Sawyer sees ". . . no reason why the growth of demand facing firms should vary systematically with the size of the firm," since the firms are in the same industry, they should be producing products that are close substitutes. Therefore, he believes that the large firm is faced with supply conditions more advantageous to growth and is better able to exploit increases in demand.

Sawyer notes that the large firm tends to be diversified into many industries. Larger firms grow at a faster rate than smaller firms in a particular industry because diversification allows for a transference of resources as needed among different industries, while smaller firms are more dependent upon capital markets in order to fund expansion. Rogers (1982, pp. 63-64) adds that large firms may outgrow smaller firm rivals due to deep pockets, reciprocity, and strategic investment in excess capacity and heavy advertising. Therefore, the expected sign of the growth coefficient is ambiguous, although a negative coefficient is likely.

Advertising intensity, measured by the advertising-to-sales ratio (A/S) in an industry, is expected to have positive effects on concentration change due to economies of scale in advertising and other advantages large advertisers have over smaller ones (Mueller and Rogers 1980; Tokle, Rogers and Adams 1990). First, conglomerates have an advantage over smaller rivals (often single-product companies) due to their ability to employ cross-subsidization and shared resources. Second, large firms have both real and pecuniary scale advantages in advertising. In addition, a lagged effect from advertising could be a factor on concentration change. Tokle, Rogers and Adams, following Mueller and Rogers, found that electronic media (TV, radio) are the more effective advertising media for increasing concentration. However, the concentrating effect no longer appears after 1982 (see Rogers and Tokle) and hence either a new equilibrium level of concentration has been established with this newer promotional medium or other more unforeseen factors swamp the effect from electronic advertising.

Industry size (S) should be negatively linked to change of market concentration. In a review of the determinants of concentration, Scherer states (1990, p. 120) that, "It seems clear that large market size, absolute or (especially) in relation to MOS plant scales, is a significant inhibitor of high concentration." Also, Mueller and Hamm (1974, p. 514) state that, "Other things being the same, the larger the absolute size of an industry, the lower its entry barrier." I abandon the hope of finding an empirical measure of Sutton's relative setup cost for 5-digit product classes. Given that MES and KO can only be measured at the 4-digit SIC level and given concerns about the limitations of these measures, I have lost hope that Census derived measures of MES provide useful information because of their bias and the interactions with other variables, namely ICR, Size, and even A/S. Hence, I do not attempt to use the 4-digit MES measures used in Sutton's empirical analysis with the product class data used in the concentration change analysis.

Given this brief review, we now combine these traditional determinants of concentration change with variables that capture large firm involvement in specific markets. The new focus here is to test the significance of the change in large firm involvement on change in market concentration. The other independent variables will be the usual ones: market size, initial concentration, market growth, and the advertising-to-sales ratio, plus those which represent changes in large firm involvement within an industry.

A Model of Market Concentration Change

The special tabulation of the census of manufactures used in Connor et. al. used the 100 largest food and tobacco companies to represent large firms in food and tobacco processing. In updating the special tabulations of the Census of Manufactures for 1982 and 1987, and now the requested tabs for 1992 and 1997, the top 100 was also featured. I define a "large firm" as being among the top 100 food and tobacco firms, based on value-added in a given year.

Based on this definition of a large firm, two variables will be used to measure large firm involvement in a market. First, I use the change in the number of firms from the top 100 largest firms that operate in each industry (i.e., the number from 1987 minus the number from 1982). This is the simplest measure of the change in large firm involvement, but it fails to account for the depth of involvement by the large firms. A firm with a minor presence counts the same as one holding the largest market share. Nevertheless, the measure should capture whether large firms

are entering or exiting a particular market. The predicted sign of this variable is unclear. If the market has few large firms, say 1 or 2, and only 1 or 2 more large firms enter the market, concentration could rise as the large firms trigger intense rivalry, with the smaller firms losing market share in the process. However, if several additional large firms enter the market that already has 5 or 6 large firms, the resulting competition should decrease market concentration through the new entry. The sign of the effect is clear, however, for negative changes in the number of large firms. As large firms exit an industry, it signals both fewer firms, and hence increased concentration, and a giving-up on the part of the exiting large firms, which also should increase concentration in the hands of the remaining firms. Often when a large firm cannot secure a leadership position in a market it looks elsewhere to invest its resources.

The second measure of large firm involvement in a market is a more accurate gauge of the depth of involvement by the large firms. It measures the change in the percentage of value of shipments accounted for by the top 100 collectively in each industry (VST100). It can vary from zero to 100 percent. The change in large firm involvement is then the percentage held in 1987 minus the share held in the earlier period. As the share held by the large firms increases, the industry should experience increased market concentration as these large firms settle in for a life of competition among the few. Conversely, should the collective share held by the top 100 decline, the market's concentration should decrease as the industry's structure fragments. Hence, a positive sign is expected for this measure of the change in large firm involvement.

Both variables should be useful in explaining concentration change. Just as the count of large firms in a market cannot account for the depth of involvement, the percent of industry's sales accounted for by the large firms cannot capture the number of large firms involved. A single large firm could control a new monopoly position in a market or several large firms could be present in a market with none of them holding a significant market share. Hence, both measures are used in the model.

Since none of the concentration-change determinant theories develops a clear mathematical formulation among the dependent and independent variables, a general linear form is the most appropriate first step in testing significance. Thus, the dynamic model of market concentration consists of a set of conventional variables, and the variables that reflect the change of large firm's involvement.

This model is specified as follows:

$$\ÄCR4 = f(ICR4, SIZE, GROWTH, TVR/S, ÄTVR/S, ÄTOP100\#, ÄTOP\%VS)$$

where

ÄCR4: change in CR4 over time ($CR4_t - CR4_{t-1}$)

ICR4: initial $CR4_{t-1}$

SIZE: market size (natural log of value of shipments in t-1)

GROWTH: market growth (VOS_t)/VOS_{t-1})

TVR/S: initial level of electronic advertising-to-sales ratio %

ÄTVR/S: change in electronic advertising-to-sales ratios ($A/S_t - A/S_{t-1}$)

ÄTOP100#: change of the top 100 company numbers in an industry ($CO_t - CO_{t-1}$)

ÄTOP%VS: change of sales in an industry held by top 100 firms, ÄTOP%VS = PV_t - PV_{t-1}, PV = (VOS held by the top 100 / VOS of the whole industry) * 100.

With the following expected signs:

Positive: TVR/S, ÄTVR/S, ÄTOP%VS.

Negative: ICR4, SIZE, GROWTH (probably), ÄTOP100# (probably).

Data Description

In this study, a twenty year (1967-1987) cross-sectional data set of 97 food and tobacco manufacturing markets was assembled, where we can examine the 1977-1987 decade and the 1977-1987 decade separately and test for structural change. Typically the 5-digit product classes best correspond to the economic definition of a market in the food manufacturing sector. However, at times the 5-digit product class is too narrow (e.g., beer) and a broader definition is more appropriate. At times we used a 4-digit industry because the 5-digit product classes were affected by changes in SIC definitions that affect the 5-digit level but not the 4-digit industry level.

There were 160 five-digit SICs in 1987 classified within the food and tobacco manufacturing sector. The 160 represent the maximum number of observations before we adjust for the appropriate market definition. The missing observations are mainly due to data availability and changing SIC definitions over time. The value of shipments from the 97 observations accounted for 85%, 88%, and 81%, respectively, of the total value of shipments in food and tobacco

industries in the years 1967, 1977, and 1987. The 97 observations represent the food manufacturing sector well, both in diversity and average characteristics.

This study required data that were not published in the 1987 Census of Manufacturing, breaking a data set that reached back to the 1958 Census. The Census decided that to publish product class concentration data was too expensive in 1987. With support from the Agricultural Cooperative Service of the U.S.D.A. and the Food Marketing Policy Center at the University of Connecticut, we purchased the data required for 1987 in a special tabulation. With the additional help of the Food Systems Research Group of the University of Wisconsin we are in the process of updating these data with 1992 and 1997 special tabulations.

To test for any possible change in the economic environment which may lead to change in industrial structure over the twenty years, the data are divided into two periods: 1967-1977 and 1977-1987. This allows us to test each period separately, and then to pool and test for structural change between the two periods. For this reason, **Table 12's** statistical description of the data is reported in terms of the two time periods.

Table 12: Descriptive Statistics on Concentration-Change Model's Variables, 1967-1987

Variable	Mean	St. Dev.	Minimum	Maximum
1967:				
CR467	48.47	19.46	15	93
VOS67	728.4	1099.7	19.7	7398.5
TVRS67	1.47	2.52	0	13.97
CO67	11.93	5.93	1	28
PV67	48.6	22.85	2.45	99.75
1977:				
CR477	50.42	20.02	18	98
VOS77	1591	2193.2	43	14096
TVRS77	1.05	1.87	0	11.45
CO77	12.68	7.09	2	32
PV77	49.92	23.28	5.21	99.99
1987:				
CR487	57.52	19.62	19	98
VOS87	2720.3	3958.9	46.9	21184
TVRS87	1.34	2.62	0	16.67
CO87	10.85	6.10	1	27
PV87	54.58	23.22	7.50	99.00
1967-1977:				
CCR4	1.95	7.62	-21	25
GROWTH	2.33	0.77	0.71	4.64
ÄTVR/S	-0.41	1.29	-7.92	1.91
ÄTOP100#	0.74	3.54	-7	9
ÄTOP%VS	1.32	11.92	-24.27	35.54
1977-1987:				
CCR4	7.09	10.61	-20	36
GROWTH	1.63	0.71	0.34	5.66
ÄTVR/S	0.30	1.41	-2.73	8.10
ÄTOP100#	-1.84	3.68	-13	9
ÄTOP%VS	4.66	14.64	-42.88	37.66

Source: Census of Manufactures, and a Special Tabulation of the Census.

From this statistical table, several key points should be noted. First, the overall level of market concentration increased over the two periods, with a more significant jump in the second period, 1977 to 1987. Second, the average number of large firms from the top 100 in a product class is about 12 in 1967. This suggests that the average market has several large firms participating and hence, any net entry among the top 100 firms would likely promote competition and decrease market concentration. A net exit would reduce the competitive pressure among the leading firms, thus pushing up market concentration. This supports the expectation that the estimated coefficient will be negative. Third, although the average number of large firms in a market increased (ÄTOP100# = 0.77) in the 1967-77 period, and decreased (ÄTOP100# = -1.92) in the second period, their joint share of the market increased (ÄTOP%VS increases from 1.21 to 4.90). Thus in the 1977-87 period the average number of large firms in a market decreased while the collective share they held increased.

To focus on concentration change, **Table 13** has the mean concentration level in each Census year since 1967 for the 97 observations, given by the degree of product differentiation, based largely on advertising efforts to build and maintain brand loyalty among consumers. As can be seen, the producer goods showed the greatest increase in concentration, but most of this increase came in the 1977 to 1987 period. This differs from past results where the producer goods actually declined or held a steady level of concentration and it was the highly differentiated product classes that experienced the largest increases. The next highest increase came from the low differentiated markets, again suggesting a different pattern to past studies of either all manufacturing industries (Mueller and Rogers) or just food industries (Rogers). These descriptive statistics indicate that perhaps the time has come where the effects of advertising can no longer increase concentration even in the food and tobacco processing markets. Such a result would align with Rogers and Tokle's finding for a concentration study for all manufacturing industries from 1967 to 1992.

Table 13. Average Four-Firm Concentration Ratios by Product Differentiation, 97 U.S. Food and Tobacco Product Classes, 1967 to 1987

Year	All Product Classes	Producer Goods	Consumer Goods Product Classes		
			Low Advertising	Medium Advertising	High Advertising
	n = 97	n = 29	n = 22	n = 21	n = 25
1967	48.5	45.0	38.7	46.7	62.6
1972	49.4	45.4	39.4	47.5	64.3
1977	50.4	45.3	40.6	48.4	66.7
1982	54.3	51.9	45.5	51.8	66.8
1987	57.5	56.6	48.2	55.7	68.4
Change 1987 to 1967	9.1	11.5	9.5	9.0	5.8

Empirical Estimates

The results of the model estimated by ordinary least square (OLS) regression are shown in **Table 14**. The general results of the first period, 1967 to 1977, are largely consistent with previous findings on the commonly used variables. Television advertising can offset the normal deconcentrating influences of initial concentration and growth. The only new results are related to the two aggregate concentration variables and they are strongly significant and add greatly to the model.

The next decade, the 1977 to 1987 period, does not produce such standard results in that television advertising-to-sales ratio falls to insignificance. Growth increases in its estimated effect and its significance. The aggregate concentration variables remain highly significant as they were in the former decade. A chow-test was used to determine if there was complete structural change between the two periods and the results suggested that the changes observed were not sufficiently strong to support structural change. Hence the data are pooled for a test which covers the entire twenty year period. The third column of the table gives the pooled model's results, which strongly support the results of the first two tests done on each period separately, except for television advertising remains insignificant. A check on whether this variable alone had changed between the two periods was also inconclusive.

Initial market concentration ICR4 is negatively related to changes of market concentration, consistent with most previous studies, but was more significant in the first period (at a 1% level), whereas it fell in significance in the second time period (5%). Although SIZE has the predicted sign for both periods, the estimated coefficients are not significant at the 5% level (it is significant at 10% level in the 1977-87 period and in the overall 1967 to 1987 period). This indicates that market size as a factor associated with decreased concentration, as found in some earlier empirical work, is only weakly supported in this study.

Table 14. Regression Results Explaining Concentration Change in 97 U.S. Food and Tobacco Manufacturing Industries, 1967 to 1987

Independent Variables	Time Period		
	1967 to 1977	1977 to 1987	1967 to 1987
Constant	9.1	21.2	22.0
ICR	-.09[b] (-2.84)	-.08[a] (-1.64)	-.15[b] (-2.98)
TVR/S	.92[b] (2.30)	-.48 (-1.26)	.06 (.20)
ÄTVR/S	.44 (.52)	.31 (.45)	-.13 (-.18)
Size	-.19 (-.31)	-1.42[a] (-1.71)	-1.56[a] (-1.68)
Growth	-1.01[a] (-1.39)	-2.13[a] (-1.65)	-.12 (-.47)
ÄTOP100#	-.67[b] (-3.28)	-.85[b] (-3.79)	-1.46[b] (-4.64)
ÄTOP%VS	.30[b] (5.04)	.38[b] (4.55)	.37[b] (5.83)
$\bar{R}^2$	.30	.31	.35

[a]Significant at 10% significance level.

[b]Significant at 5% significance level.

Initial electronic media advertising, TVR/S, was positively related to concentration change in the first period, and significant at the 5% level, but not significant in the second period. This indicates that electronic media was a major factor of concentration change in the 1960s and 1970s but not so in the 1977 to 1987 period. This result differs with Rogers' earlier findings and is further evidence that the 1980s were different from pervious periods in regard to the effect heavy advertising had on concentration change. It is consistent with Rogers and Tokle's findings for all manufacturing over the 1967 to 1992 period. Perhaps the mergers and acquisitions of the 1980s overwhelmed the concentrating effect previously associated with heavy advertising. The results also show that the change of the A/S ratio, ÄTVR/S, is not a significant factor in concentration change.

Market growth is a significant factor decreasing market concentration. It is significant at the 10% level in the first period and at the 5% in the second period. This supports the reasoning that market growth can offset rising concentration. High market concentration is hard to maintain with high market growth. Food and tobacco industries are mature industries, not known for rapid growth, but even here a growing market can deconcentrate itself, all else equal. Interestingly, market growth over the longer 1967 to 1987 period is completely insignificant, an unforeseen result.

Both of the large-firm involvement variables, ÄTOP100# and ÄTOP%VS support expectations. ÄTOP100# is negatively related to concentration change and is significant at the 1% level in both periods. This result is consistent with at least three explanations for why concentration increases as large firms leave a market. First, large scale economies are involved and may have increased, thus an industry can no longer support as many large firms, and some of the firms, even large ones, must exit for efficiency reasons. Second, competition may force some large firms out of the industry due to rivalry. Finally, some large firms may lose their interest in the industry once it becomes clear that they will not become the 1st or even 2nd largest firm in the market and will have to compete mainly on efficiency and price. Whichever reason dominates, the result is higher concentration after some of the large firms exit an industry.

The results from the second measure of large firm involvement, ÄTOP%VS, suggest that as the largest firms collectively gain a greater share of business in an industry, market concentration tends to increase. Such an increase is either efficiency based or related to the market power advantages available to such large firms. Hence, we are left with the most vexing question of industrial organization: "Is it efficiency or market power?".

Comparing these results to earlier empirical models of market concentration change shows the present study is a mix of the conventional variables, such as initial concentration, market size, growth, and advertising intensity that have been used in many different studies and a new set of variables on the collective involvement of large firms in markets. The new variables are the net change of number of large firms in a market (ÄTOP100#)) and the change of value of shipments collectively held by large firms in a market (ÄTOP%VS). It is the second set of variables that distinguish this empirical work from earlier studies.

The conventional variables perform much as has been seen in prior studies, with the big exception that electronic advertising intensity lost its statistical significance after 1977. Whether this result

suggests a new equilibrium level of concentration has emerged in those industries that adopted this new medium or merely a noisy period of rapid consolidations that a simple concentration model cannot account for awaits further study.

The new finding of this study is the significance of the large firm involvement in changing market concentration. Although the large firm involvement is not explicitly addressed in the economic literature of the determinants of market concentration, the actions of the largest firms are tied to the fundamental determinants. For example, in food and tobacco it is the leading 100 firms that account for essentially all of the electronic advertising. The relationship between large firm involvement in various markets helps establish the link of aggregate concentration and market concentration. This finding adds evidence that large firms not only contribute to increasing the aggregate concentration of the sector, but also to increasing market concentration. Thus, the use of large firm involvement variables has improved our understanding of the link between aggregate concentration and market concentration.

The "New" 1992 Product Class Concentration Data

A special tabulation of the 1992 Census allows us to examine another five years of concentration data. Unfortunately, we still await the 1997 data. The trends above continue, with electronic advertising explaining concentration change over the longer periods starting with 1967, but not in more recent decades. **Table 15** gives the simple mean CR4s by the degree of product differentiation, as measured by advertising intensity. The reversal of average concentration changes in the producer goods product classes and the low advertising users from the earlier period, 1967 to 1977, and the later period, 1982 to 1992 is similar to the pattern seen in **table 8** and figure 4 for the longer period of 1958 to 1992. The gap between the mean CR4 of the highest advertising group and the producer goods was cut in half over the 1967 to 1992 period–from 17.1 points to 8.8 percentage points.

Table 15. Average Four-Firm Concentration Ratios by Product Differentiation, 96 U.S. Food and Tobacco Product Classes, 1967 to 1992

Year	All Product Classes	Producer Goods	Consumer Goods Product Classes		
			Low Advertising	Medium Advertising	High Advertising
	n = 96	n = 29	n = 21	n = 21	n = 25
1967	48.9	45.5	39.6	46.7	62.6
1972	49.6	45.4	39.9	47.5	64.3
1977	50.8	45.8	41.2	48.4	66.7
1982	54.5	51.9	46.1	51.8	66.8
1987	58.1	57.6	49.0	55.7	68.4
1992	60.9	61.3	53.8	56.4	70.1
Change:					
1967-1977	1.9	0.3	1.6	1.7	4.1
1982-1992	6.1	9.4	7.7	4.6	3.3

Source: Census of Manufacturing, including Special Tabulations.

Below are the 96 observations that were used in the 1967 to 1992 analysis, sorted by concentration change from 1967 to 1992 (**table 16**).

Table 16. Concentration Data, 1967 to 1992. Sorted by Change in CR4, 1967 to 1992.

SIC87	Pd 87	Name87	Nl 87	Vos67e	Vos92	Tvrs67	Tvrs87	Cr467	Cr472	Cr477	Cr482	Cr487	Cr492	Cr46792	Cr46777	Cr48292
20820	3	Malt beverages (sic2082, 1982)	0	2900.3	17301.667	4.06	4.66	40	52	65	78	87	92.0	52.0	25.0	14.0
20980	1	Macaroni, spaghetti, and noodles	0	207.3	1280.0	0.67	0.45	31	34	32	44	73	76.2	45.2	1.0	32.2
20111	1	Beef, not canned or made into sau	0	7398.5	26943.3	0.00	0.01	26	30	25	44	58	70.2	44.2	-1.0	26.2
20119	0	Hides, skins, and pelts	0	276.3	1993.5	0.00	0.00	32	30	23	38	58	74.0	42.0	-9.0	36.0
21310	2	Chewing & smoking tobacco, and	0	193.8	1507.6	1.23	0.12	50	60	65	75	84	86.2	36.2	15.0	11.2
20115	1	Lard	0	182.2	105.6	0.00	0.00	33	37	39	40	40	68.6	35.6	6.0	28.6
20792	3	Margarine	0	456.5	1415.2	5.34	3.70	47	54	60	55	80	81.9	34.9	13.0	26.9
20133	2	Canned meats	0	856.4	1455.201	0.50	0.86	34	41	36	53	60	66.0	32.0	2.0	13.0
20411	0	Wheat flour, except flour mixes	0	1557.7	4192.4	0.25	0.03	37	37	38	48	54	68.7	31.7	1.0	20.7
20416	0	Other grain mill products	0	43.0	173.4	0.00	0.00	46	51	67	75	75	77.5	31.5	21.0	2.5
20412	0	Wheat mill products other than flo	0	204.3	494.4	0.03	0.00	35	37	39	50	54	65.2	30.2	4.0	15.2
20338	2	Jams, jellies, and preserves	0	245.2	922.3	0.96	1.75	35	40	49	47	57	65.1	30.1	14.0	18.1
20352	2	Pickles and other pickled products	0	260.6	1206.9	0.40	0.57	29	38	40	43	48	58.8	29.8	11.0	15.8
20960	2	Potato chips and similar products	0	648.0	7527.404	3.03	1.48	41	49	52	62	62	70.0	29.0	11.0	8.0
20112	1	Veal, not canned or made into sau	0	307.7	283.0	0.00	0.00	37	27	32	55	64	65.2	28.2	-5.0	10.2
20335	2	Canned vegetable juices	0	104.2	409.4	1.66	1.71	62	62	67	73	78	88.5	26.5	5.0	15.5
20773	0	Animal and marine oil mill product	0	96.3	203.2	0.00	0.00	41	42	44	53	60	66.3	25.3	3.0	13.3
20151	1	Young chickens	0	1849.5	12642.3	0.01	0.27	17	18	23	32	42	42.1	25.1	6.0	10.1
20771	0	Grease and inedible tallow	0	302.6	975.1	0.00	0.00	23	22	25	31	37	48.1	25.1	2.0	17.1
20851	0	Distilled liquor, except brandy	0	202.3	643.6	0.00	0.00	50	49	54	60	67	75.0	25.0	4.0	15.0
		means for group		914.6	3258.3	0.907	0.78	37.3	40.5	43.75	52.8	61.9	70.28	32.98	6.45	17.48
20333	1	Canned hominy and mushrooms	0	51.6	202.0	0.31	0.26	39	39	53	69	66	62.8	23.8	14.0	-6.2
20830	0	Malt and malt byproducts	0	200.0	573.3	0.00	0.00	42	49	60	61	64	65.5	23.5	18.0	4.5
20113	1	Lamb and mutton, not canned or r	0	312.7	335.0	0.00	0.00	57	55	58	59	73	80.2	23.2	1.0	21.2
20744	0	Cottonseed cake, meal, & byprodu	0	148.0	373.6	0.00	0.00	40	39	42	52	40	61.5	21.5	2.0	9.5
20114	1	Pork, fresh and frozen	0	2791.0	9647.7	0.00	0.00	33	37	37	39	38	53.8	20.8	4.0	14.8
20762	0	Vegetable oils	0	113.4	465.2	0.00	0.00	52	53	40	56	67	72.5	20.5	-12.0	16.5
20741	0	Cottonseed oil, crude	0	114.8	102.1	0.00	0.00	43	43	41	59	60	62.9	19.9	-2.0	3.9
20751	0	Soybean oil	0	594.3	2454.6	0.00	0.00	55	51	53	59	71	73.5	18.5	-2.0	14.5
20763	0	Other vegetable oil mill products	0	41.8	188.2	0.00	0.00	53	61	48	72	84	71.4	18.4	-5.0	-0.6
20132	2	Sausage and similar products (not	0	2286.6	7300.09	0.44	0.97	19	17	22	26	40	36.0	17.0	3.0	10.0
20743	0	Cotton linters	0	38.0	54.7	0.00	0.00	41	40	44	47	44	57.6	16.6	3.0	10.6
20153	1	Turkeys, incl. frozen, whole and p	0	504.7	2881.1	0.51	0.27	28	40	42	40	38	44.5	16.5	14.0	4.5
21210	2	Cigars	0	362.1	264.6	3.53	1.20	58	55	54	58	69	73.4	15.4	-4.0	15.4
20237	0	Concentrated milk products (bulk)	0	79.3	903.3	0.00	0.00	31	29	33	35	58	46.3	15.3	2.0	11.3
20623	0	Refined cane and beet sugar and	0	1887.0	5053.866	0.16	0.09	63	62	65	65	86	78.0	15.0	2.0	13.0
20131	1	Pork, processed or cured in meat	0	2008.0	5535.056	0.24	0.00	22	22	18	22	30	36.0	14.0	-4.0	14.0
20261	0	Bulk fluid milk and cream	1	923.5	3035.5	0.00	0.00	17	23	25	28	28	31.0	14.0	8.0	3.0
21110	3	Cigarettes	0	2942.1	28839.4	7.93	0.00	80	84	88	90	92	92.9	12.9	8.0	2.9
20331	2	Canned fruits, except baby foods	0	818.3	2371.9	0.63	0.69	34	35	37	44	49	46.8	12.8	3.0	2.8
20752	0	Soybean oil, cake, meal, & byproc	0	1143.4	6424.5	0.00	0.00	56	53	49	56	72	68.8	12.8	-7.0	12.8
20772	0	Feed and fertilizer byproducts	0	277.8	1497.7	0.00	0.00	20	19	20	27	32	32.1	12.1	0.0	5.1
20470	3	Dog and cat foods (sic2047, 1982	0	699.9	6316.233	5.98	4.21	46	54	58	58	58	58.0	12.0	12.0	0.0
20761	0	Linseed oil	0	48.0	79.5	0.00	0.00	86	98	98	100	98	98.0	12.0	12.0	-2.0
20874	3	Other flavoring agents, except cho	0	410.6	2697.0	2.88	2.05	59	68	76	70	78	69.8	10.8	17.0	-0.2
20661	0	Chocolate coatings	0	137.8	589.5	0.00	0.00	56	54	62	64	68	66.3	10.3	6.0	2.3
20610	0	Sugar cane mill products and byp	0	363.5	1433.2	0.00	0.00	42	43	42	41	48	52.0	10.0	0.0	11.0
20853	3	Bottled liquors, except brandy	0	1043.8	2584.0	0.01	0.01	53	51	54	49	52	62.9	9.9	1.0	13.9
		means for group		753.4	2956.4	0.84	0.36	45.37	47.19	48.85	53.56	59.37	61.28	15.91	3.48	7.72

20460	0	Wet corn milling (sic2046, 1982)	0	646.6	6415.571	0.04	0.00	64	63	61	73	74	73.0	9.0	-3.0	0.0	
20510	2	Bread, cake, and related products	1	4320.0	14572.179	0.73	0.69	25	27	32	32	34	34.0	9.0	7.0	2.0	
20670	3	Chewing gum	0	271.9	1106.3	13.06	16.67	81	84	93	87	90	90.0	9.0	12.0	3.0	
21410	0	Tobacco stemming and redrying	0	1112.0	3749.1	0.00	0.00	67	66	66	68	65	76.0	9.0	-1.0	8.0	
20354	3	Mayonnaise, salad dressing, and s	0	373.9	3339.7	2.97	1.45	55	52	60	61	63	63.9	8.9	5.0	2.9	
20238	0	Ice cream mix and related produc	0	201.1	743.5	0.00	0.00	15	16	22	21	27	23.8	8.8	7.0	2.8	
20951	3	Roasted coffee, whole bean or gro	0	1375.3	3763.4	1.77	1.53	56	60	57	62	63	64.5	8.5	1.0	2.5	
20662	3	Chocolate & Choc-type candy ma	0	205.0	1495.6	0.67	10.23	82	82	82	85	90	90.0	8.0	0.0	5.0	
20343	1	Dried and dehydrated fruits and ve	0	344.9	2124.3	1.50	0.48	32	32	39	48	41	39.3	7.3	7.0	-8.7	
2033C	3	Canned fruit juices, fresh & from c	0	413.5	4548.0	0.91	0.67	31	29	34	35	36	38.0	7.0	3.0	3.0	est CR4
20321	2	Canned baby food, except cereal	0	246.3	856.1	0.80	1.32	93	95	98	100	97	99.8	6.8	5.0	-0.2	
20372	2	Frozen vegetables	0	579.9	4411.2	0.66	0.48	34	35	34	36	42	40.8	6.8	0.0	4.8	
20159	0	Liquid, dried and frozen eggs	0	159.6	866.2	0.00	0.02	43	36	30	33	41	49.4	6.4	-13.0	16.4	
20342	3	Soup mixes, dried	0	76.4	592.4	4.10	4.00	73	75	78	76	75	79.3	6.3	5.0	3.3	
20996	1	Vinegar and cider	0	56.7	228.5	0.67	0.00	53	48	54	58	53	58.9	5.9	1.0	0.9	
20952	3	Concentrated coffee	0	365.6	819.7	6.96	6.31	85	88	88	95	97	90.7	5.7	3.0	-4.3	
20991	3	Desserts (ready-to-mix)	0	218.2	708.8	8.43	3.76	81	80	81	80	82	86.0	5.0	0.0	6.0	
20332	1	Canned vegetables, except homir	0	957.5	2694.4	0.66	0.20	38	35	38	35	42	42.6	4.6	0.0	7.6	
20336	3	Catsup and other tomato sauces,	0	507.7	3671.6	2.52	2.68	55	56	52	48	55	59.6	4.6	-3.0	11.6	
20993	3	Sweeting syrups and molasses	0	138.8	611.6	4.44	2.88	54	53	52	58	57	58.5	4.5	-2.0	0.5	
20371	2	Frozen fruits, juices, ades, drinks,	0	419.5	2864.0	1.12	0.88	30	41	36	40	41	34.2	4.2	6.0	-5.8	
20840	3	Wines, brandy, and brandy spirits	0	410.2	4050.0	3.17	6.15	48	53	49	52	45	52.1	4.1	1.0	0.1	
20154	1	Other poultry and small game	0	19.7	73.9	0.00	0.00	81	69	75	74	84	85.0	4.0	-6.0	11.0	
20430	3	Cereal breakfast foods	0	715.7	7733.624	13.97	12.41	82	84	81	81	82	86.0	4.0	-1.0	5.0	
20236	1	Canned milk products, except sub	0	475.5	1202.3	3.03	0.02	62	69	72	74	65	65.6	3.6	10.0	-8.4	
20263	1	Cottage cheese	1	218.0	769.6	0.49	0.32	36	27	25	29	32	39.2	3.2	-11.0	10.2	
20323	2	Canned dry beans	0	246.1	1119.5	1.35	0.79	49	50	51	48	53	51.4	2.4	2.0	3.4	
20440	2	Milled rice and byproducts	0	548.0	1617.9	1.14	1.43	45	42	47	44	53	46.7	1.7	2.0	2.7	
20872	3	Liquid beverage bases, not for sof	0	129.9	158.8	0.08	5.37	74	65	78	62	58	75.7	1.7	4.0	13.7	
20994	1	Baking powder and yeast	0	79.0	316.0	0.42	0.00	81	89	78	81	79	82.7	1.7	-3.0	1.7	
20322	3	Canned soup	0	481.0	1986.2	3.04	4.28	93	95	95	95	94	94.0	1.0	2.0	-1.0	
20860	3	Bottled and canned soft drinks (sic	1	2996.8	23776.371	3.81	2.03	89	89	86	90	86	90.0	1.0	-3.0	0.0	
		means for group		603.4	1755.1	2.58	2.72	58.97	58.91	60.13	61.28	62.38	64.40	5.43	1.16	3.12	

20522	3	Cookies, wafers, and ice cream co	0	832.2	4168.9	1.45	2.47	51	55	55	54	52	50.6	-0.4	4.0	-3.4	
20262	1	Packaged fluid milk and related pr	1	4454.9	11732.7	0.09	0.03	25	19	18	18	26	24.4	-0.6	-7.0	6.4	
20268	1	Other packaged milk products, n.e	1	286.0	886.6	0.91	0.37	31	29	32	31	32	29.9	-1.1	1.0	-1.1	
20910	1	Canned & cured seafood, incl sou	0	421.1	1139.4	1.63	0.17	34	38	37	44	22	30.8	-3.2	3.0	-13.2	
20235	1	Dry milk products, except substitu	0	632.0	2876.8	2.78	0.34	35	45	38	33	31	31.3	-3.7	3.0	-1.7	
20224	2	Process cheese and related produ	0	562.5	5068.4	0.48	0.51	72	60	59	64	71	68.0	-4.0	-13.0	4.0	
20155	2	Processed poultry and small game	0	141.8	6020.1	0.00	1.26	50	34	42	37	36	43.9	-6.1	-8.0	6.9	
20669	2	Other chocolate & cocoa products	0	245.0	943.2	1.83	0.69	70	69	69	69	69	63.7	-6.3	-1.0	-5.3	
20353	3	Prepared sauces, except tomato	0	98.5	1754.3	4.00	3.89	47	50	49	52	45	40.6	-6.4	2.0	-11.4	
20223	2	Natural cheese, except cottage ch	0	829.2	10078.6	0.44	0.29	38	36	32	31	35	31.2	-6.8	-6.0	0.2	
20970	0	Manufactured ice	1	85.8	343.2	0.00	0.00	32	29	22	17	19	25.0	-7.0	-10.0	8.0	
20521	3	Crackers, pretzels, biscuits, & rela	0	550.0	3208.9	1.53	2.92	71	68	70	74	71	63.3	-7.7	-1.0	-10.7	
20742	0	Cottonseed oil, once refined	0	56.2	183.9	0.00	0.00	75	62	54	60	60	66.1	-8.9	-21.0	6.1	
20240	3	Ice cream amd ices	1	1273.6	5278.0	0.38	2.14	32	27	27	22	22	22.5	-9.5	-5.0	0.5	
20413	0	Corn mill products	0	262.0	775.7	0.10	0.24	62	60	62	57	59	52.5	-9.5	0.0	-4.5	
20791	2	Shortening and cooking oils	0	1233.9	4020.2	1.02	1.03	53	50	47	47	46	38.5	-14.5	-6.0	-8.5	
20419	2	Flour mixes/refrig & froz doughs	0	644.9	3894.4	2.24	1.26	59	61	48	59	45	42.0	-17.0	-11.0	-17.0	est CR4
		means for group		741.7	3669.0	1.11	1.04	49.24	46.59	44.76	45.24	43.59	42.61	-6.63	-4.47	-2.63	
		Overall Means. Full sample		735.0	3534.0	1.48	1.35	48.91	49.59	50.82	54.50	58.10	60.89	11.98	1.92	6.39	

Notes: Pd87 is code for the degree of product differentiation, Nl87 is the national-local dummy variable, Vos67e and Vos92 are value of shipments in 1967 and 1992, Tvrs67[87] is the television-radio advertising-to-sales ratio for 1967 or 1987, and Cr4?? is the 4-firm concentration ratio for the given year.

There is wide variability in the product classes that showed great increases in concentration and those that did not. The top five are beer, pasta, beef, hides and skins, and chewing/smoking tobacco–representing all four of the advertising-intensity groups. There are large industries and small industries, high growth and negative growth industries. The one overall finding is that concentration rose over time for almost all product classes. Out of the 96 product classes, 45 posted increases in CR4 of at least 10 percentage points, and only 15 had decreases in CR4, and most of those were under 10 percentage points. The largest decline in CR4 was an observation where I estimated the 1992 CR4 because in the past, the special tabulations combined flour mixes from SIC 20415 and 20455 since they produce the same products, but the later one uses purchased flour. Of the 15 product classes with negative changes in CR4, six are from the dairy group and if one has read the food news over the last three years that trend has reversed. Suiza Foods and Dean Foods have been actively acquiring dairy companies around the country. In fact, Suiza Foods in under tentative investigations for such acquisitions in three New England states.

Concentration change has not followed a steady path since 1967. I compared the change in CR4 for the first decade, 1967 to 1977 and the last decade, 1982 to 1992 and found no correlation between the two decades (Figure 6). Only a few product classes had negative changes in CR4 in both decades (the lower left quadrant of figure 6). Producer goods did reverse their earlier declines in CR4, by posting increased CR4 in the later decade, even after declining in the first decade. The highest advertising intensity product classes were in every quadrant, but did post some of the highest increases in each decade. In figure 7, a positive relationship exists between CR4 in 1967 and 1992, but again one observes much noise and the tendency for increases rather than decreases in CR4 over time.

Figure 6.

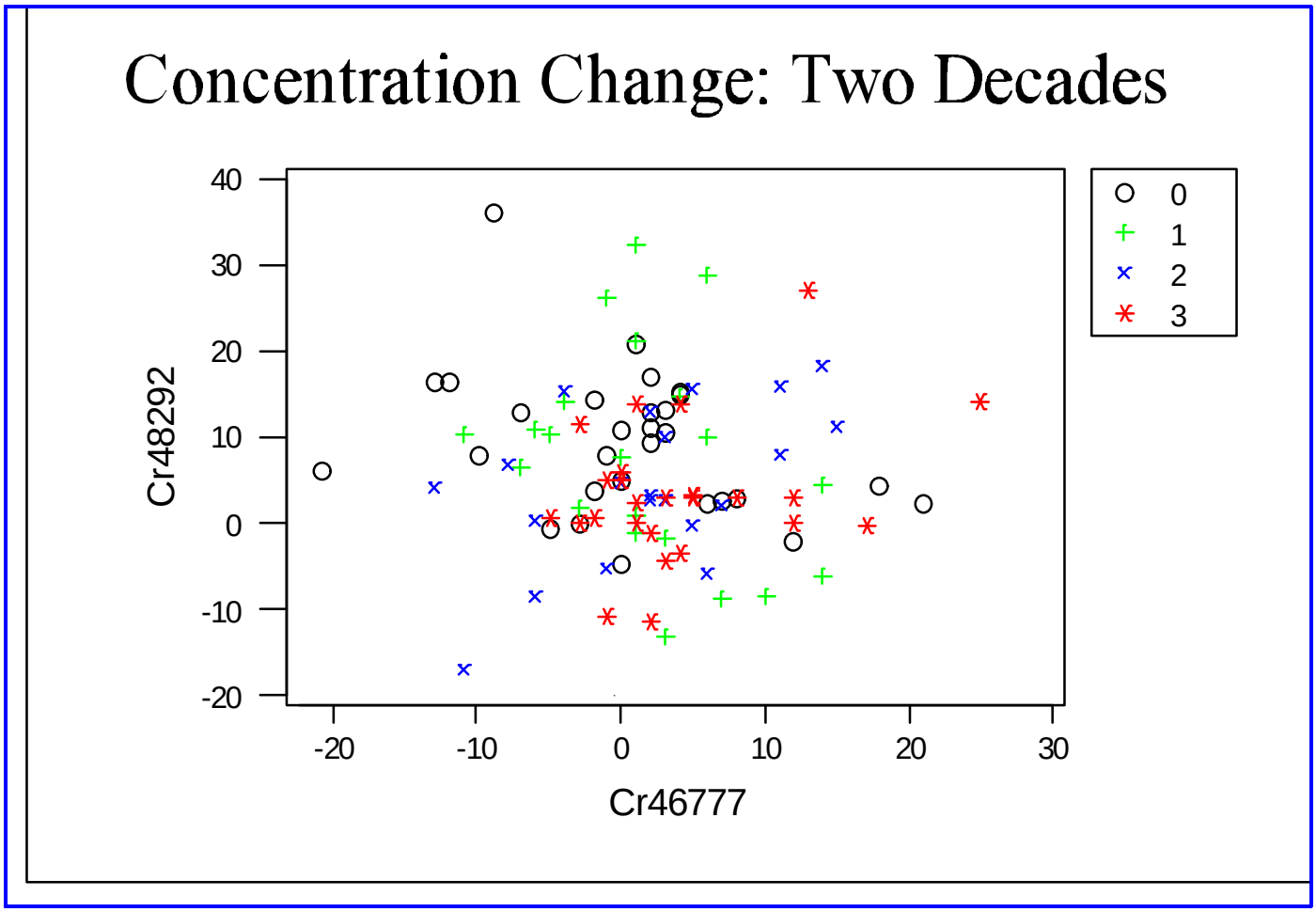
Concentration Change: Two Decades
Cr48292
Cr46777
40
30
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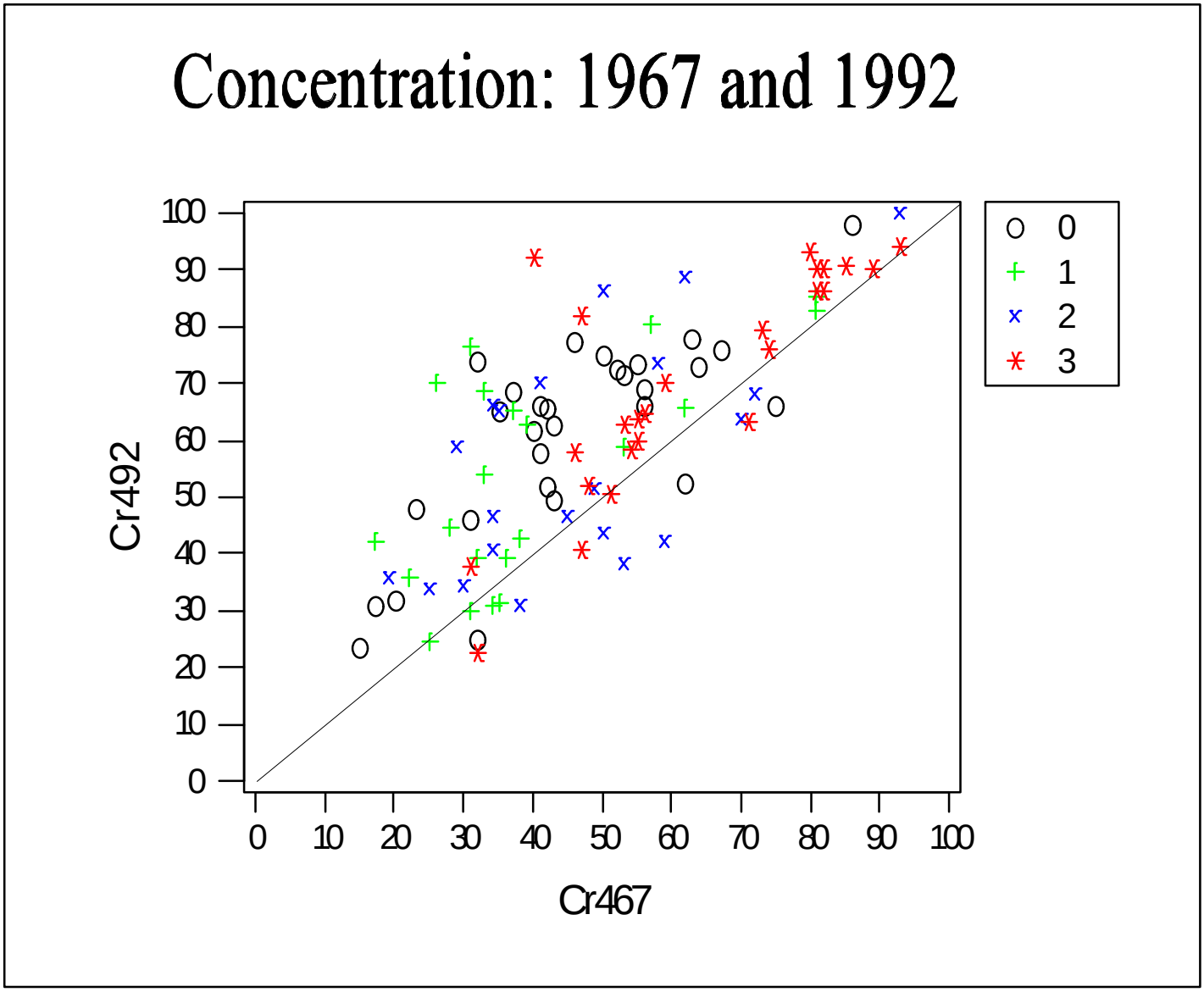
Figure 7.



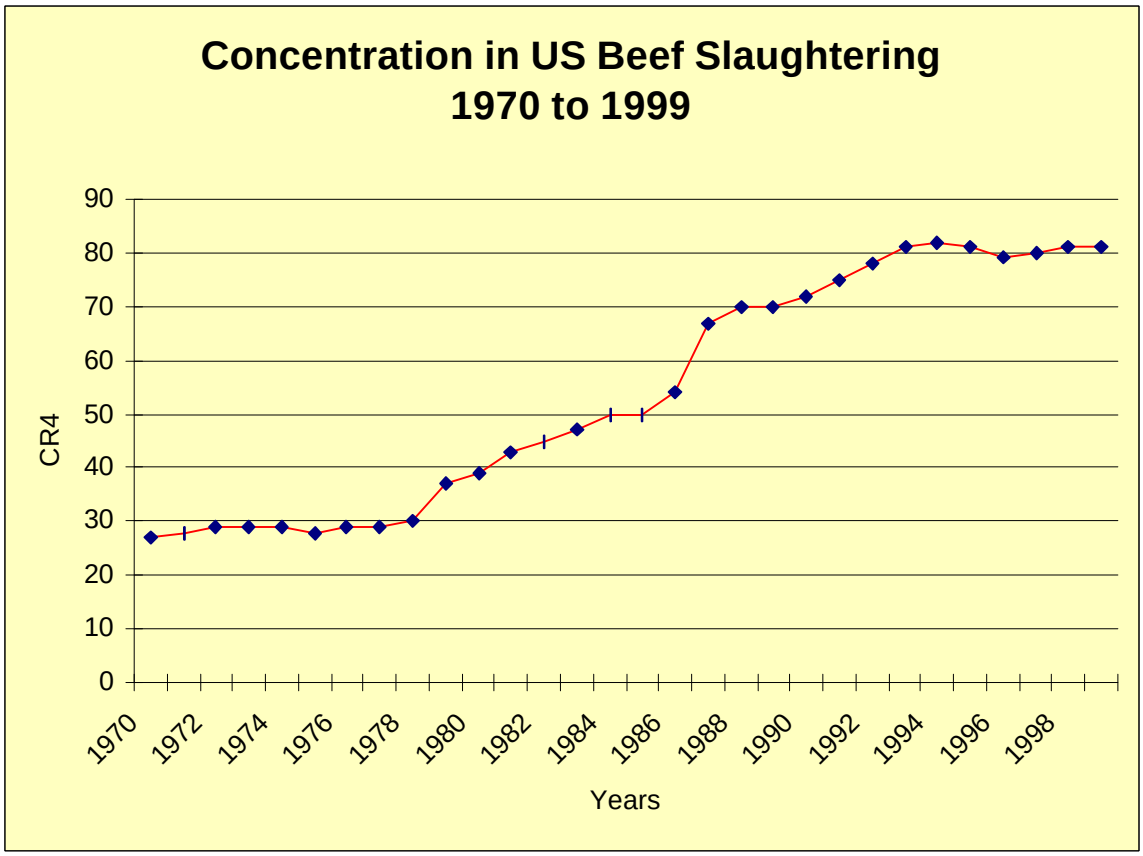
There is a difference in the pre-1977 and post-1977 concentration patterns. Marion and Kim's study of six producer good industries clearly showed the role of mergers in advancing concentration in these markets. Several of the mergers violated the Justice Department's merger guidelines, yet they went unchallenged. The current merger wave is much more horizontal in nature as firms undo conglomerate mergers of the past and acquire direct competitors or leading firms in more related lines of business. Concentration models cannot account for such rapid change in concentration. Were these mergers merely the result of lax antitrust enforcement or were producer good industries undergoing dramatic changes that required ever larger operations to capture economies of scale? Sutton's theory also points to "toughness of price competition" as a concentrating factor in markets. Is there evidence that the producer goods industries were experiencing tougher price competition? Purcell suggests meat packers were experiencing tough price competition as they faced

declining demand and a squeeze on margins making it difficult to cover sunk costs. That leads to exit and consolidation.

A look at concentration in beef slaughtering dramatically shows the pre-1977 and post-1977 patterns (Figure 8). A recent study byMacDonald, Ollinger, Nelson, and Handy point precisely to these two reasons: increased scale economies and pricing toughness. They state (p. 39): "Our evidence suggests that once new and extensive scale economies emerged in meatpacking, intense price competition led to the exit of high-cost small plants, their rapid replacement by larger and more efficient plants, and significant increases in market concentration." Several studies have examined whether increased concentration in meat packing has led to market power abuses, especially on input prices paid to ranchers, but most studies either found small abuses or insignificant differences. Farmers remain outspoken that something has changed and they are being injured by the reduced number of buyers. Consumers have not joined in the debate as food price inflation, in general, is not a headline issue. Some consumer advocates have been concerned about food retailers' slowness in passing on cost savings to consumers, yet their speed in passing on price increases. Again, studies on this issue have not supported any market power abuses by retailers (e.g., see Reed and Clark).

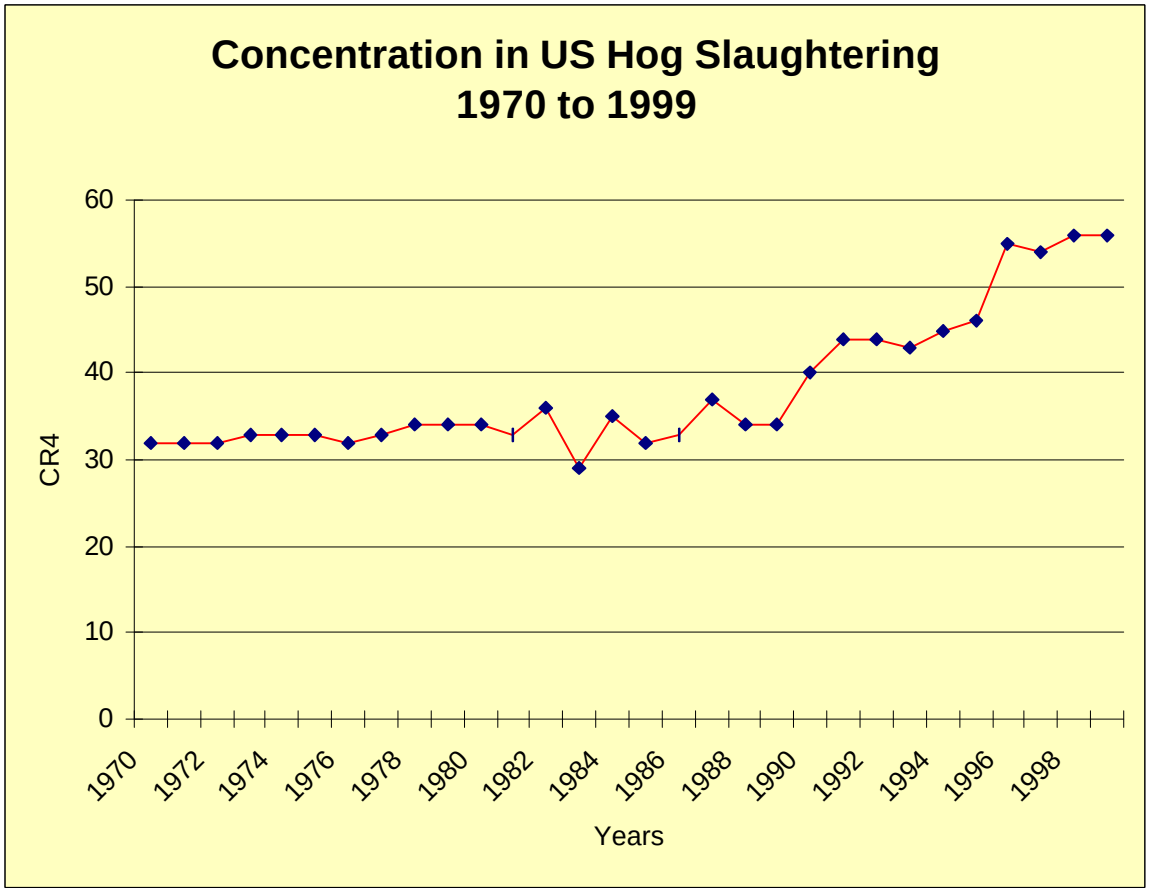
A similar but arriving a bit later has occurred in hog slaughtering (Figure 9), where the consolidations have largely been in the 1990s. The U.S.D.A. provides much more timely data on the industries that it has oversight responsibilities for than the Census Bureau provides. Some foresee the hog industry following the pattern of the broiler industry (e.g., Martinez), which has shown steady advances in concentration (Figure 10) but without seller market power abuses. Buying power abuses in more difficult to study, but despite allegations from growers, no study has found oligopsony problems in this spatially monopsonistic industry.

Figure 8.



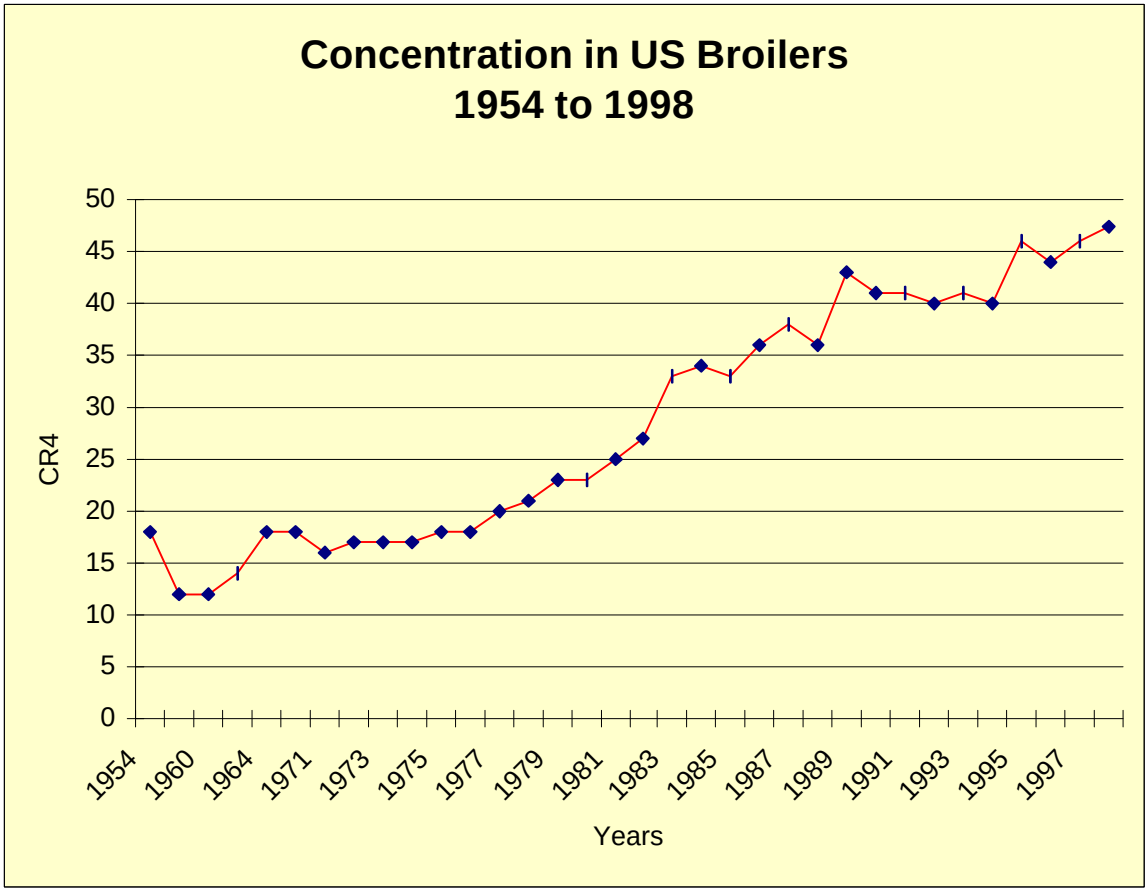
Source: Packers and Stockyards Administration, U.S.D.A.

Figure 9.



Source: Packers and Stockyards Administration, U.S.D.A.

Figure 10.



Source: Census of Manufacturing, U.S.D.A., and Broiler Industry.

Summary

Aggregate concentration in the food and tobacco processing sector has an unbroken upward trend since at least 1954. The twenty largest food and tobacco firms are an impressive and unique among the more than 16,000 food firms. They controlled 44% of the sector's value-added in 1992, up from 24% in 1967. These are massive firms with the average top 20 firm having 56 establishments, whereas even the firms which were among the second largest 100 firms had only an average of 7.3 establishments. Consolidations suggest that aggregate concentration will continue to increase as the food system enhances its bimodal size distribution. I have tried to demonstrate in this paper a positive relationship between aggregate concentration and market concentration. When the largest food firms enter a market, the outcome is not reduced market concentration but increased concentration.

Market concentration has advanced in almost every food and tobacco processing market over time. The previous finding that the rising concentration was limited to the most intensive-advertising industries has been replaced with concentration is rising everywhere. If an industry was unconcentrated, it is likely to concentrate soon, if it has not already done so in the 1990s. Milk and the other dairy industries are the next to show rising concentration, from what were once unconcentrated industries. We must now understand and monitor performance in a much more concentrated food and tobacco sector and to do so with much less public information. Seller concentration is high in many markets, but buyer concentration is dramatically higher given the special characteristics of most agricultural markets. However, far less information is available on buyer concentration than seller concentration and the later is not widely available and timely as we still await concentration data for 1997. The Census needs to do a better job by publishing more detailed concentration data and in a more timely fashion. With the rise of industrialization and contract coordination, new measures need to be found to aid policy makers in assessing the performance of our more concentrated food system.

Appendix Table A1. Product class concentration data from a special tabulation of the 1992 Census of Manufacturing. Prepared by Patrick Duck of the Census Bureau and Richard T. Rogers of the University of Massachusetts. Paid for by the Food Marketing Policy Center, University of Connecticut.

SIC92	nsk	Co92	Et92	Vos92	CR492	CR892	CR2092	CR5092	Comment
20110	nsk	1,156	1,192	2,582,018					
20111		158	531	26,943,303	70.2	79.5	88.5	96.8	
20112		34	52	283,048	65.2	91.4	99.7	100.0	
20113		31	44	335,009	80.2	95.7	99.9	100.0	
20114		104	224	9,647,669	53.8	70.7	91.4	99.3	
20115		45	66	105,582	68.6	88.7	99.2	100.0	
20116		74	283	2,016,572	57.0	75.6	95.7	99.7	
20117		94	278	1,707,086	59.4	73.1	89.0	98.2	
20118		6	7	551,500	99.9	100.0	100.0	100.0	vos estimated
20119		176	289	1,993,537	74.0	80.0	88.7	96.6	
2011B		146	279	631,100	42.6	60.4	81.4	96.4	vos estimated
20130	nsk	854	917	1,805,318					
20136		199	516	3,518,484	30.2	46.6	71.5	89.5	
20137		327	856	5,593,004	35.9	45.1	62.7	78.0	
20138		33	36	903,701	62.8	77.9	97.7	100.0	
2013B		257	379	5,865,900	20.5	33.5	57.8	80.9	
20150	nsk	277	356	1,001,723					
20151		79	390	12,642,275	42.1	57.9	82.6	98.0	
20152		25	34	106,630	48.4	82.5	99.6	100.0	
20153		47	117	2,881,071	44.5	65.4	93.3	100.0	
20154		13	16	73,900	85.0	97.3	100.0	100.0	cr4 estimated
20155		207	432	6,020,127	43.9	57.5	77.7	94.5	
20159		36	123	866,236	49.4	62.8	89.8	100.0	
20210		88	139	1,201,621	30.9	51.9	83.2	98.8	
20220	nsk	213	221	402,573					
20223		225	495	10,078,599	31.2	49.5	70.4	86.2	
20224		74	168	5,068,421	68.0	83.5	94.2	99.6	
20225		27	42	313,884	64.1	84.0	99.6	100.0	
20230	nsk	67	67	88,035					
20235		115	344	2,876,766	31.3	46.6	70.5	91.1	
20236		21	39	1,202,344	65.6	88.0	99.0	100.0	
20237		54	137	903,304	46.3	64.8	90.2	99.9	
20238		168	459	743,514	23.8	37.8	61.1	84.5	
20239		49	90	1,566,900	79.7	91.0	98.7	100.0	
20240		525	1,906	5,277,962	22.5	35.9	60.9	80.8	
20260	nsk	283	297	910,866					
20261		268	779	3,035,466	31.0	46.1	65.2	85.8	
20262		301	1,879	11,732,668	24.4	33.6	50.3	70.3	
20263		100	171	769,563	39.2	57.2	78.1	94.8	
20265		72	110	998,162	68.4	79.6	92.5	99.6	
20267		75	165	238,410	59.4	75.9	90.4	99.3	
20268		209	644	886,559	29.9	40.0	56.9	77.7	
20320	nsk	174	314	188,048					
20321		6	9	856,140	99.8	100.0	100.0	100.0	vos estimated
20322		23	36	1,986,232	94.0	98.5	99.9	100.0	cr4 estimated

20323		40	210	1,119,473	51.4	75.6	95.9	100.0	
20324		52	112	1,557,707	68.2	78.6	93.8	99.9	vos, cr50 estimated
20330	nsk	373	647	376,200					
20331		76	228	2,371,854	46.8	64.0	87.2	98.3	
20332		89	452	2,694,390	42.6	60.2	79.8	96.4	
20333		21	25	202,040	62.8	81.0	99.9	100.0	cr20 estimated
20335		33	43	409,389	88.5	94.6	99.5	100.0	
20336		99	310	3,671,644	59.6	75.6	90.5	98.9	
20338		58	242	922,300	65.1	78.5	91.7	99.5	
2033A		91	256	3,319,661	51.6	64.0	84.4	97.9	
2033B		198	384	1,228,000	29.4	44.7	65.5	84.7	
20340	nsk	81	139	69,006					
20342		23	24	592,384	79.3	94.2	99.9	100.0	
20343		73	137	2,124,300	39.3	63.0	86.5	98.3	
20350	nsk	254	441	230,141					
20352		66	225	1,206,939	58.8	72.8	91.5	99.5	
20353		152	240	1,754,331	40.6	59.4	83.1	95.7	
20354		103	257	3,339,745	63.9	72.2	85.3	97.9	
20370	nsk	122	181	132,770					
20371		91	322	2,864,000	34.2	49.7	76.4	96.8	
20372		83	456	4,411,227	40.8	58.7	86.3	98.0	
20380	nsk	213	363	222,459					
20382		147	392	5,334,582	43.3	62.8	78.3	92.7	
20384		71	117	1,662,617	46.1	65.2	87.8	99.0	
20410	nsk	171	211	213,027					
20411		73	503	4,192,416	68.7	80.4	92.6	99.2	
20412		58	204	494,367	65.2	78.6	93.2	99.8	cr50 estimated
20413		52	145	775,700	52.5	82.2	95.6	99.9	
20415		29	69	345,900	67.4	86.4	98.6	100.0	
20416		18	29	173,410	77.5	94.6	100.0	100.0	
20430	nsk	25	35	30,161					
20431		39	175	7,207,814	85.7	97.2	99.7	100.0	
20432		21	38	495,649	84.3	95.9	99.9	100.0	cr20 estimated
20440		48	198	1,617,863	46.7	68.9	93.1	100.0	
20450		222	532	3,894,394	41.5	57.3	78.7	93.3	
20460	nsk	17	18	21,424					
20461		13	71	2,910,968	82.6	98.9	100.0	100.0	
20462		23	58	1,318,100	63.0	88.5	99.2	100.0	
20463		21	39	801,579	83.9	95.7	99.9	100.0	cr20 estimated
20464		12	62	1,363,500	74.8	92.4	100.0	100.0	
20470	nsk	72	88	145,333					
20473		136	529	3,899,800	50.4	70.4	89.6	97.7	
20474		92	308	2,271,100	70.8	86.4	96.7	99.1	
20480	nsk	865	1,178	1,628,900					
20481		287	2,235	4,890,300	43.4	58.6	77.5	91.9	
20482		240	562	1,454,714	29.4	45.9	67.7	89.7	
20483		196	726	678,500	34.1	50.3	73.5	89.9	
20484		255	577	541,879	42.5	57.3	79.3	92.4	
20485		186	719	1,181,400	34.9	59.8	88.3	95.7	

20486		218	499	524,200	46.7	59.3	74.8	90.5	
20487		175	616	623,000	39.0	57.3	80.6	94.4	
20488		282	1,543	511,900	37.3	49.9	68.4	85.7	
20489		220	627	469,600	23.7	36.1	57.8	82.4	
2048A		190	981	747,400	36.0	53.3	74.2	92.5	
20510	nsk	1,687	1,697	764,231					
20511		405	1,699	5,983,852	36.3	52.6	69.7	84.3	
20512		386	1,292	4,037,000	28.0	42.2	60.9	80.6	
20513		189	325	840,375	50.0	65.7	81.9	93.2	
20514		209	341	1,888,228	58.8	76.2	88.3	96.1	
20515		129	174	415,243	52.6	75.2	88.7	97.5	
20516		120	127	144,891	61.2	76.5	90.2	96.8	
20517		114	171	498,359	69.2	77.8	88.8	98.1	
20520	nsk	234	235	111,697					
20521		98	221	3,208,923	63.3	75.7	88.7	98.3	
20522		231	659	4,168,900	50.6	67.3	85.4	95.3	
20530		249	412	1,863,953	37.3	49.8	71.8	86.4	
20610		40	91	1,433,246	52.0	67.8	88.0	100.0	
20620		20	131	2,864,143	82.8	98.1	100.0	100.0	
20630		15	280	2,189,723	72.6	93.4	100.0	100.0	
20640	nsk	468	831	339,827					
20642		189	218	5,167,290	65.1	74.4	86.2	94.5	
20643		190	233	3,370,100	32.7	49.7	69.6	87.5	
20648		10	22	1,106,300	90.0	99.0	100.0	100.0	all crs estimated
20649		26	28	84,400	63.5	80.5	99.4	100.0	
20660	nsk	126	127	62,477					
20661		28	76	589,480	66.3	92.2	99.9	100.0	
20662		10	14	1,495,645	90.0	98.0	100.0	100.0	cr4,8 estimated
20669		78	147	943,153	63.7	78.9	95.2	99.8	
20680		136	365	2,671,075	43.2	55.7	77.6	94.8	
20740	nsk	15	30	14,638					
20741		16	27	102,101	62.9	88.1	100.0	100.0	
20742		12	19	183,889	66.1	92.6	100.0	100.0	
20743		17	36	54,749	57.6	81.6	100.0	100.0	
20744		24	92	373,599	61.5	79.6	99.4	100.0	
20750	nsk	36	77	47,299					
20751		24	90	2,454,587	73.5	91.2	99.9	100.0	
20752		32	172	6,424,500	68.8	88.7	99.7	100.0	
20760	nsk	10	12	14,512					
20761		7	9	79,500	98.0	100.0	100.0	100.0	cr4 estimated
20762		30	54	465,200	72.5	86.3	98.3	100.0	
20763		21	53	188,210	71.4	91.2	99.9	100.0	cr20 estimated
20770	nsk	117	222	167,500					
20771		135	325	975,100	48.1	65.6	78.4	91.4	
20772		182	503	1,497,700	32.1	48.7	72.7	90.1	
20773		41	75	203,200	66.3	80.9	96.2	100.0	
20790	nsk	50	83	38,260					
20791		71	225	4,020,200	38.5	62.7	86.4	99.7	
20792		22	45	1,415,212	81.9	90.7	99.9	100.0	cr20 estimated

20820	nsk	136	221	124,736					
20821		23	114	10,636,227	93.1	99.4	99.9	100.0	
20822		40	244	4,861,750	91.2	97.4	99.4	100.0	
20823		37	118	1,026,274	90.5	95.9	99.2	100.0	
20824		33	145	652,680	87.3	94.2	99.6	100.0	
20830		18	29	573,279	65.5	96.4	100.0	100.0	
20840		524	1,381	4,050,025	52.1	66.1	79.2	87.3	
20850	nsk	24	37	27,922					
20851		14	39	643,600	75.0	90.0	100.0	100.0	all crs estimated
20853		29	193	2,583,951	62.9	82.6	97.9	100.0	
20860	nsk	490	886	1,426,657					
20863		222	4,330	7,456,576	40.9	49.8	63.8	80.6	
20864		145	1,826	9,941,320	52.6	60.1	73.9	90.0	
20865		146	457	1,052,418	58.3	66.4	79.2	91.9	
20866		323	815	3,899,400	51.0	61.3	79.7	90.8	
20870	nsk	204	348	445,000					
20871	no	76	124	513,400					all crs suppressed
20872		27	41	158,800	75.7	87.3	99.2	100.0	
20873		60	125	2,981,516	89.6	94.0	98.0	99.9	
20874		97	162	2,697,000	69.8	78.8	89.0	97.3	
20910		179	302	1,139,401	30.8	49.8	72.2	92.1	
20920	nsk	410	451	629,784					
20922		184	325	983,600	23.0	37.5	56.9	78.8	
20923		129	352	2,732,415	30.2	43.5	72.8	93.5	
20925		122	270	1,549,800	31.4	45.7	69.6	92.3	
20926		54	78	596,865	25.2	44.5	82.7	99.9	
20950	nsk	84	98	120,256					
20951		72	160	3,763,364	64.5	74.8	89.8	99.0	
20952		24	32	819,684	90.7	94.3	99.8	100.0	
20960	nsk	232	258	182,532					
20961		72	130	3,263,209	69.2	78.4	92.6	99.0	
20962		123	225	3,010,688	76.5	82.8	90.3	97.3	
20963		78	126	1,070,975	58.7	73.2	87.2	98.1	
20970		517	736	343,200	25.0	32.5	43.4	59.8	
20980		190	271	1,279,955	76.2	85.0	92.0	95.8	
20990	nsk	1,236	1,311	1,465,664					
20991		46	72	708,800	86.0	91.8	98.3	100.0	
20993		76	107	611,636	58.5	73.0	90.6	99.3	
20994		29	56	315,951	82.7	94.5	99.9	100.0	
20996		62	117	228,500	58.9	78.0	93.8	98.6	
20999		370	521	2,365,200	26.7	35.6	50.0	68.6	
2099A		68	105	1,122,344	82.6	92.1	97.3	99.8	
2099B		124	252	2,198,800	40.3	59.6	80.1	96.1	
2099D		49	86	1,106,100	76.3	89.8	97.7	100.0	
2099E		85	176	1,122,300	56.2	69.5	88.4	99.0	
2099F		39	59	1,269,720	74.2	87.1	98.1	100.0	
2099G		155	185	1,661,300	38.6	53.2	74.0	90.3	
21110		10	33	28,839,444	92.9	99.9	100.0	100.0	cr8 estimated
21210		27	42	264,619	73.4	88.7	99.8	100.0	

21310		27	51	1,507,555	86.2	96.5	99.9	100.0	
21410	nsk	14	14	12,097					
21411		9	11	179,957	83.4	99.8	100.0	100.0	vos estimated
21412		17	31	3,067,916	75.6	96.4	100.0	100.0	
21413		7	9	489,130	99.2	100.0	100.0	100.0	vos estimated

Note: all estimated values were done by Richard T. Rogers, University of Massachusetts.

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